CANMET

Canada Centre for Mineral and Energy Technology

Centre canadien de la technologie des minéraux et de l'énergie

COAL RESEARCH LABORATORIES ANNUAL PROGRESS REPORT 1986-1987

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FOREWORD

Continued attention to the twin processes of technology transfer and consultation with industry has characterised all of the research activities of the Coal Research Laboratories throughout 1986/87.

Three CANMET sponsored/organized international symposia in western Canada involved all elements of staff in program planning jointly with the regional industry and universities. Industry-wide seminars describing recent research were held in both Hinton and Devon. In particular, a review of laboratory programs in Bitumen/Oil emulsion characterisation provided a number of opportunities for the development of collaborative research programs with industrial companies. These programs are continuing through joint laboratory and plant activities in which CRL staff provide the scientific expertise and company engineers the operational skills and experience.

The organization structure of the division remained unchanged throughout the year. Geographically the Calgary-based research group was relocated to Devon and simultaneously renamed the Surface Mining Laboratory to more closely reflect the reality of its research programs. The parallel change of name -- the Edmonton Coal Research Laboratory to the Fuel Processing Research Laboratory -- reflected the expanding importance of particle separation technologies to the oil industry of western Canada.

A major new geotechnical and processing program has been initiated jointly with the Alberta Oil Sands Technical Research Association at the Fort McMurray site of their Underground Test Facility. This project sustains CANMET's leadership in underground mining research in the development and understanding of a novel Canadian technology.

These collaborative activities demand flexibility of approach to ensure that the programs are relevant, timely and useful. Industrial perceptions of these qualities will, in large measure, dictate the nature and extent of much of our future joint research.

AVANT-PROPOS

Les activités de recherche des Laboratoires de recherche sur le charbon en 1986-1987 ont été caractérisées par un intérêt continu pour le double processus de la consultation industrielle et du transfert technologique.

Trois symposiums internationaux, organisés et subventionnés par le CANMET et présentés dans l'Ouest canadien, ont fait appel aux employés travaillant à la planification des programmes conjointement avec l'industrie et les universités de la région. Des séminaires à l'échelle industrielle décrivant les récents travaux de recherche ont eu lieu à Hinton et à Devon. Plus particulièrement, un examen des programmes de laboratoires sur la caractérisation des émulsions bitume/pétrole a offert certaines possibilités pour la mise sur pied de programmes coopératifs de recherche avec des sociétés industrielles. Ces programmes se poursuivent dans le cadre d'activités conjointes en laboratoire et en usine pour lesquelles le personnel des LRC fournit les connaissances scientifiques et les ingénieurs des sociétés, les compétences et l'expérience pratique.

La structure de la division est demeurée la même durant toute l'année. Le groupe de recherche situé à Calgary a été déménagé à Devon et, par la même occasion, nommé le Laboratoire d'exploitation à ciel ouvert afin de refléter plus fidèlement les programmes de recherche qui y sont réalisés. Parallèlement, le Laboratoire de recherche sur le charbon d'Edmonton a été renommé le Laboratoire de recherche sur le traitement des combustibles, changement qui démontre l'importance grandissante des technologies de séparation des particules dans l'industrie pétrolière de l'Ouest canadien.

Un important programme de géotechnique et de traitement a été créé conjointement avec l'Alberta Oil Sands Technical Research Association dans les installations d'essais souterrains du chantier de Fort McMurray. Ce projet renforce le rôle du CANMET en tant que chef de file dans la recherche sur l'exploitation minière souterraine, en ce qui a trait à la mise au point et à la compréhension d'une nouvelle technologie canadienne.

Ces activités communes exigent de la flexibilité afin d'assurer la pertinence, l'opportunité et l'utilité des programmes. La façon dont ces qualités sont perçues par l'industrie dictera, en grande partie, la nature et l'étendue de bon nombre de nos projets conjoints de recherche dans l'avenir.

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HIGHLIGHTS

CAPE BRETON COAL RESEARCH LABORATORY

This year has seen the consolidation of the activities of the laboratory within its permanent renovated premises at 210 George Street, Sydney, Nova Scotia.

During the course of the year, a Micro Vax II minicomputer was installed with five terminals within the laboratory, as was also, a Conspec Model 10 terminal linked to the Conspec computer at Lingan Colliery which monitors methane emission and airflow patterns from the operating longwall sections at that colliery on a continuous basis.

Representative of many laboratory activities was a joint USBM/CANMET survey of methane emission patterns from longwall districts at Lingan Colliery. This study covered a three-week period in June-July 1986 and involved up to nine members of this laboratory's staff as well as two investigators from the USBM attending for continuous periods of up to ten hours underground per day.

The equipping of this laboratory is now nearly completed. There remains only some ducting to be installed by the Department of Public Works and the acquisition and installation of a Tinius-Olsen rock test frame from MRL in Ottawa.

The laboratory will continue to serve the Cape Breton Development Corporation (CBDC) as a main client but its continuing existence signals its strong ability to transfer technology to Western Canada if and when such technology transfer might be required.

SURFACE MINING LABORATORY

Last year the laboratory began a process of consultation with industry to solicit input in the direction of research to be undertaken, promote durable mechanisms for greater industry involvement in the planning and conduct of research, encourage industry to participate financially in specific research projects and increase industry awareness of the work of the Surface Mining Laboratory. Those activities continued this year with the circulation to industry of a series of discussion documents, increased

emphasis on mine-site visits and the organization of two industry oriented surface mining technology symposiums.

The first generation of cooperative research projects with industry are now underway. Those projects include work with individual firms and broader generic projects in which a consortium of private sector interests are represented. The willingness of industry to participate in cooperative R&D in spite of the well publicized downward pressure on product pricing and the resulting difficulties is most encouraging.

The work of the laboratory was dislocated by the July 1986 relocation from Calgary to the Coal Research Centre at Devon. The fact that the laboratory was able to make a smooth and effective transition to surface mining R&D at a new geographical location and industry's willingness to participate in cooperative R&D are the result of a strong staff commitment to succeed within the new framework and mandate of the laboratory.

In a technical sense, the highlight of the year must be the success of the laboratory's efforts to initiate cooperatively funded work with industry. The six such projects initiated this year are described later in this report. External financial participation in these projects totals $730,000 while CANMET's financial participation totals $475,000. Cooperative projects where formal cost sharing agreements do not exist are not included in these totals although they are also financially significant.

FUEL PROCESSING LABORATORY

The current review period has been characterized by a substantial enhancement of interaction and a strengthening of ties between the staff of the Fuel Processing Laboratory (FPL) and the industry. This has been a direct result of a concerted effort to improve industrial opportunities to input into R&D activities on one hand and to facilitate technology transfer back to the industry on the other.

This has been achieved using a number of vehicles including the presentation of in-house program review meetings and technology workshops, polling of industry views on various R&D issues and industry-wide surveys designed to identify current pressing industrial concerns.

Examples of these include:

A meeting at Devon attended by participants from 13 oil companies and 2 provincial government agencies to review the oil emulsion treatment program.

An industry-wide survey of coal producers was conducted in the field by research staff through meetings and discussion at both the technical and managerial levels of various companies to identify specific problem areas and to obtain feedback on proposed projects in such areas as fine coal recovery, mobile plants and process control.

A one day workshop on the subject of water treatment for washery effluents was organized and conducted in-house by research staff. It was attended by washery operators and environmental engineers representing most of the coal producing companies.

These initiatives have proved to be fruitful in bettering mutual understanding and in reinforcing existing working relationships between the laboratory and industry. Additional benefits have been an increased level of awareness of research capabilities and a better focus on relevant issues concerning the industry. The success of these efforts is now embodied in CANMET's new five-year plans and in a substantial increase in the level of cost recovery and cooperative projects presently underway.

CAPE BRETON COAL RESEARCH LABORATORY

RESEARCH AND DEVELOPMENT

STRATA MECHANICS

Gateside Pack Performance

In March 1985, CBDC installed the first monolithic pump packing system in the maingate of 9E at Lingan Colliery. CBCRL assisted in the design of this pack and monitored its effect on gateroad support and gob leakage. In April 1986, CBDC installed a second pump packing system in the 10E maingate at Lingan Colliery and once again CBCRL assisted in its design and is monitoring its effect on gateroad support and gob leakage.

The monolithic pumped packing system used by CBDC is an 'Astrapack' system and although better than conventional wood packs is more expensive because it contains specially treated materials imported from the U.K. Both CBDC and CBCRL have therefore continued to investigate the possibility of using materials indigenous to Nova Scotia, such as flyash, anhydrite and gypsum. Research has continued into the potential use of a flyash/cement mix, which if successful, would create an attractive alternative to the more expensive imported materials. Work has therefore been directed at investigating the behaviour of different mix ratios and a preliminary surface trial was conducted at Lingan Colliery. An extensive CBDC program into the design of an underground mixing delivery system, using flyash/cement, was completed by L.E. Shaw Ltd. of Halifax, with contributions from CBCRL and a fully mechanised packing system proposal is currently being prepared for submission to CBDC.

At McGill University, work has continued under an EMR RAP grant to assess the potential of alternative pumped packing materials. Initially, the work concentrated on assessing the behavioural characteristics and mechanical properties of materials currently used by CBDC. However, the program is now expanding to include sources of anhydrite, gypsum and flyash indigenous to Nova Scotia.

Barrier Pillar Design Criteria

McGill University (under an EMR-RAP grant) has completed the three-year analysis of an extensive gateroad deformation data base collected in the Sydney Coalfield. The final report has been submitted to the Laboratory and the results are expected to be published later in the year.

Roadway Support Systems

An alternative and potentially more effective method of supporting gateroads has been investigated under a research contract by the Technical University of Nova Scotia (TUNS). Essentially, the concept involves the installation of hollow steel arches in the gateroad, which are subsequently filled with a grout/cement mix. The result is a support system which is lighter and much easier to handle than the heavy H-section steel arches currently used. The research contract demonstrated that grout filled steel tubes could produce a bending resistance equivalent to normal arch steel for a 37% reduction in weight.

Further research was also conducted at TUNS with the assistance of a grant from CBDC on the bending behaviour of full-scale hollow section steel arches.

A final report detailing the results is currently in preparation. It should also be noted that this work has lead to the establishment at TUNS of the only known full-scale mine arch testing facility in Canada.

CBDC is currently examining alternative methods for the support of major intersections in the main arterial roadways of its Lingan and Phalen Mines. At present, the intersections are supported by massive steel 'I' beams. However, the introduction of lighter section steel beams combined with rock bolts could result in a more effective support system which is both simpler and cheaper to install. A joint CBCRL/CBDC medium-term research program was therefore established to instrument and monitor the behaviour of existing intersection designs and use the results to assess the potential of several alternative methods.

In 1986, CBDC experienced a number of falls of ground in the main slopes (or arterial roadways) of Lingan Colliery. CBCRL has therefore been involved in the development of an instrumentation program to monitor areas of potentially bad ground and provide some measure of early warning with regard to an impending failure. In November 1986, a major junction at Lingan Colliery, identified as being potentially unstable, was instrumented in order to monitor its long-term stability.

Rock/Gas Outbursts

Since 1977, thirty-seven events identified as outbursts have occurred in the No. 26 Colliery workings below a depth of 700 m. The early

events were described as roof falls because of their docile nature and because no methane emission was recorded. However, the two most recent events in November 1983 and January 1984 were particularly violent and resulted in the temporary halt of further 'main deeps' development until a method of control could be implemented. The November 1983 occurrence demolished 18 arches, ejected 300 m^3 of rock and over 750 m^3 of methane. The January 1984 occurrence demolished 16 arches, ejected over 150 m^3 of rock and almost 3,200 m^3 of methane.

The ejected material consisted of pulverized fine/medium grained sandstone. The outbursts only occurred where the overlying sandstone unit came within 2.7 m of the top of the coal, the development roadway was being driven using 'drill and blast' methods and the depth of cover exceeded 700 m. Research to investigate the outbursts phenomena experienced at No. 26 Colliery has continued following closure of that colliery since other CBDC operations are expected to reach similar depths and geological environments within the next five years.

In September 1986, a research contract was awarded to Golder Associates to undertake the development and laboratory validation of a theoretical model for rock/gas outbursts experienced in the Sydney Coalfield. In addition to identifying a suitable outburst model and validating it using available field data, the contract will also undertake further investigations into the role of the rate of stress change on the incidence of bursting. A previous contract, 'Development and Use of Triaxial Rock Testing Procedures for Samples from the Sydney Coalfield', successfully demonstrated the dependence of outbursts and their severity on triaxial stress conditions and the rate of change in stress as well as the physical properties of the material (porosity, permeability and pore gas pressure).

To obtain further information for the outburst program, a detailed series of in-situ stress determinations were undertaken at the Prince and Lingan Mines. The program used both the USBM overcoring and minifracing techniques in a variety of different lithological units. In addition, the program allowed a preliminary evaluation of minifracing techniques in an underground coal mine environment and an assessment of its performance in weak coal measures strata, such as coal and mudstone. At Prince Mine, the results indicated a slightly anisotropic stress field with the ratio of the

major to minor principal stresses being about 2.0. At Lingan Mine, relatively greater anisotropy was seen, with the ratio of the major to minor principal stresses being 2.8. Field work on the program commenced in September 1985, with the completion of Prince Mine in November 1985 and Lingan Mine in February 1986. The final report was submitted to the Laboratory and the results presented to industry via a seminar in September 1986.

Evaluation of Submarine Subsidence Guidelines

Existing guidelines for the safe working of undersea coal reserves indicate that between 8.75 mm/m (N. America) and 10 mm/m (U.K.) of tensile strain associated with subsidence development can be induced at seabed before the risk of water occurrence to the mine workings becomes unacceptable. In the United Kingdom, a minimum of 105 m of coal measures strata is required between the working seam and the base of a major aquifer horizon or seabed, while in the U.S.A. a minimum of 60 m of cover is required for every 1 m of extracted seam height.

The applicability of existing undersea subsidence guidelines to the Sydney Coalfield is uncertain since they were derived primarily from European land truthed data which has been extrapolated to undersea conditions rather than derived empirically from seabed truthed data. CBCRL has therefore initiated a long-term program to measure actual seafloor subsidence development, produce effective predictive techniques and establish safe working guidelines for the Sydney Coalfield.

During the year, work centered on a research contract undertaken by McGregor Geoscience Ltd. of Halifax to examine archival geophysics data from the Sydney Coalfield, N.S., to identify seafloor longwall subsidence profiles. Unfortunately, the results neither confirmed nor rejected the presence of seafloor subsidence profiles and the report identified two principle factors for the failure of the previous surveys. Firstly, in order to identify subsidence profiles it is absolutely essential to know what the seafloor looked like prior to mining. Secondly, the instrumentation schemes used did not have sufficient resolution to identify the presence of subsidence profiles even if they existed. It should be noted that all the historical surveys examined were conducted for geological and/or bathymetric purposes and not for the purposes of identifying seafloor subsidence profiles.

The application of geophysical techniques for monitoring the development of seafloor subsidence profiles over the new Phalen mine resource block were also examined.

In addition, a detailed investigation was undertaken to examine the potential subsidence interaction effects likely to occur between the proposed Phalen Seam (Phalen Mine) workings and those already located in the overlying Harbour Seam (Lingan Mine).

Rock/Support Interaction

In December 1984, the Lovat full face TBM completed its drivage of the Donkin-Morien No. 2 tunnel. The tunnel advanced a total distance of 3350 m in 11 months. An extensive geotechnical program, resulting from the submission of an unsolicited proposal (awarded to Golder Associates in February 1983) and undertaken in conjunction with CBDC and CANMET, was completed and the final report submitted in January 1986. During the year, the results of this work were presented, with the assistance of the CANMET's Office of Technology Transfer, to the mining industry via a series of seminar presentations held at sixteen universities across Canada.

In March 1986, the Lovat TBM was installed at the bottom of the No. 3 tunnel drill and blast section (1030 m) and used to complete the drivage of the tunnel to the Harbour Seam (3550 m). The No. 3 tunnel was completed in February 1987. A geotechnical monitoring program was drawn up by CBCRL, in conjunction with CBDC and eight extensometer sites installed in areas identified as having potentially bad or difficult ground conditions. Between May and September 1986, problems with the main bearing of the tunnel boring machine resulted in the driving of a 40 m long cross-cut, from the No. 2 tunnel to the No. 3 tunnel, to intersect the head of the TBM. The purpose of the cross-cut was to allow access to and transportation of the TBM main bearing. A geotechnical monitoring program was initiated by CBCRL to monitor strata behaviour in the vicinity of the TBM during the development of the 'bearing' cross-cut.

Other Projects

Current research programs have demonstrated a need for rock strength data for various strata types encountered in the Sydney Coalfield.

Since CBCRL's rock testing facilities are not yet fully operational, a program of irregular sample point load testing was initiated to establish a preliminary geotechnical data base. Uniaxial compressive and tensile strength values were calculated from the point load index tests both parallel and perpendicular to the bedding plane and an anisotropy index calculated.

This program has continued with the development of an IBM compatible computer program which undertakes the calculation of point load indices as well as uniaxial compressive and tensile rock strengths. The point load testing data base was expanded with the collection and testing of coal samples from the Phalen Seam, Phalen Mine. In addition, a detailed analysis of the complete point load data base is being undertaken on the Micro Vax II using the DATA PLOT statistical package.

An IBM compatible computer program was developed in August 1986 for the calculation of uniaxial compressive rock strengths from Schmidt Hammer Rebound indices. In addition, discussions are currently in progress to establish a joint CBCRL/CBDC laboratory based, medium-term research program to investigate the relationship between rock strength, hardness and abrasivity and the life expectancy/amount of wear experienced by roadheader cutter picks.

Rock Mechanics Laboratory

The Rock Mechanics Laboratory is nearly operational. The core drill has continued to malfunction and remedial measures are currently under discussion with both the manufacturers and CANMET's Technical Services Division.

A stiff test frame is under fabrication locally with delivery in early 1987, while the MRL Tinius-Olsen frame is expected to arrive in the autumn of 1987.

COAL MINE ENVIRONMENTS

Gob Leakage

Studies continued during the year on gob leakage in cooperation with the Strata Mechanics Group. From field data collected, the groups were able to draw the following conclusions with respect to the effect of monolithic packing at Lingan Colliery upon gob leakage, namely that:

a) there were significant increases in the volumes of air reaching the bottom of the faces on the 9E and 10E sidewalls.
b) monolithic packing as practised on those east sidewalls would permit the mining for a length of 2500 m of a longwall advancing panel without resort to a cundy.

Development of Field Tracer Gas Analysis Systems

This work has continued with a long-term objective of developing a system capable of analysing multiple tracer gases in a real-time mode. A number of significant developments arose during the year, namely:

a) the development and application of a rapid sequential SF_6 analyser suitable for use in underground mines.
b) the identification of alternative tracer gases to SF_6 suitable for using as mine tracer gases and the development of these by field testing.
c) involvement with Canada's hard-rock mining industry in initial experiments with recirculation ventilation.

Other Projects

Additional field investigations were also conducted on the following:

a) calculation of CH_4 production from 9E panel at Lingan Colliery.
b) prevention of CH_4 accumulations above Lingan Colliery's coal silo draw points.
c) the measurement and evaluation of post-fan shutdown airflow at Lingan Colliery.
d) evaluation of Seiger BM2H methanometer's cross-sensitivity.
e) detailed evaluation of CBDC's anemometry techniques.

Assistance was also given to CBDC staff with an emergency planning scheme for Lingan Colliery.

Airborne Respirable Dust

The objective of CBCRL's respirable dust research is to monitor and develop measures to control airborne respirable dust levels in underground coal mines and thereby reduce the risk of coal workers' pneumoconiosis and pulmonary disorders.

During the period December 1985 - June 1986, twelve face-time and nine portal-to-portal dust surveys were conducted at Prince Colliery. The results are reported in a divisional report ERP/CRL 86-131(CF). Dust measurements were made in two producing wall sections (4W and 6E walls), one development heading (3 deep) and the top level development for another wall section (5W wall).

Face-time surveys included fixed location sampling and personal sampling. Measured dust levels were presented as equivalent concentrations in accordance with a practice assigned by the Mining Research Establishment (MRE) of the British National Coal Board. The correlations derived from multiple regression analysis between longwall face workers' personal exposure and control point measurements indicated the need for additional field surveys. These were planned and are currently in progress.

Numerous respirable dust sampling systems or samplers are commercially available for the determination of dust concentrations in underground coal mines. For the purpose of assessing long-term dust exposure, evaluating the effectiveness of dust control techniques or setting work environmental standards, the results obtained by measurements using different samplers must be reproducible and comparable. To this end, various respirable dust sampling systems have been field tested and their precision, reproducibility and relative performance have been studied. The results were presented in a paper to the International Symposium on Respirable Dust in the Mineral Industries in October 1986.

Some correlation studies have also been made between the total respirable dust generation in a production shift and pertinent operating variables for longwall mining.

Mineralogical and elemental composition of the airborne respirable dust is fundamental to the understanding of the health risk of such mixed dust exposure. Therefore, an investigation to determine the true mineralogical composition of airborne coal mine dust using STEM and XRD techniques has been proposed. Various analytical facilities were visited within CANMET and discussions were held with appropriate scientists with a view to proceeding with STEM and XRD techniques.

Methane

The objective of CBCRL's methane research is to improve the management and control of methane emissions in underground coal mines and thereby contribute to the enhancement of health, safety and productivity of the Atlantic Canada's underground coal mining industry.

To contain the methane emission hazard, it is necessary to deliver adequate quantities of air to strategic zones in the mine workings and where necessary supplement this with effective methane drainage. The ability to predict methane emission volume is a vital element in the ventilation planning process. A comprehensive and critical review of methane prediction techniques practised in a number of major coal producing countries was completed (DSS Contract Serial No. OSQ85-0024). The study concluded that, based on the geological setting of the Cape Breton Coalfield, the methods of mining practised combined with the potential for free exchange of technical information, the development of the Canadian prediction method should be modelled on the Western European techniques in general and that practised in the United Kingdom in particular. Most of these techniques are empirical in nature and to some degree site specific. They have been developed from practical experience aligned with the measurement of actual emissions over long periods. These are further supplemented by a comprehensive data base on in-situ gas content, adsorption/desorption, petrographic and permeability characteristics of coals and other strata.

To achieve the goal of developing a computer-based methane prediction model with real-time inputs, a number of in-house and contract research projects have been initiated.

1) The collection of methane emission data from Lingan Colliery on real-time basis is accomplished by the installation of a Conspec processor at CBCRL and connecting it to the Lingan Conspec computer by a direct data link. Lingan Colliery is equipped with an environmental monitoring system. The system consists of suitable sensors installed at strategic locations in each operating district, main return airways, the surface fan and the methane extraction plant and a series of outstations designed to collect and transmit the data from a group of sensors to the surface computer.

At the present time, we are collecting one-minute sample data from about forty sensors and storing it for analysis and future use.

2) A project to conduct a detailed review of operational experience with the Canadian developed CONSPEC monitoring system is in progress and is expected to be completed by July 1987. The results will be useful not only in evaluating the reliability of the system but also will provide the first step in developing a comprehensive computer-based mine management information system with the potential to significantly improve efficiency and productivity.

3) In order to monitor and control methane concentrations, methane liberation patterns in coal mining panels must be identified. This need has led to a joint research effort between CANMET and the United States Bureau of Mines. The patterns were studied using continuous reading methanometers with data loggers installed at strategic locations in the panel roadways, the coalface and on the shearer. Other relevant information such as the methane captured in the drainage system, coal production, changes in the barometric pressure, etc. were also recorded. A joint report is in preparation and the results will be presented in a paper to the 3rd U.S. Mine Ventilation Symposium in October 1987.

4) To conduct various studies on Canadian coals, an automated state-of-the-art apparatus was designed in four modules and is being built for delivery later this year. The apparatus will enable us to:
   - determine methane content of coals,
   - study rate of emission content of coals,
   - study adsorption/desorption characteristics, and
   - study parameters that lead to coal outbursts.

5) The need to measure methane concentrations in inaccessible areas such as roof cavities, open gob areas, sections of roadways that are temporarily unfit to travel before repair, unsupported areas

in shortwalls and longwall faces, methane layers in high roadways, etc. was identified. However, all the methane monitors available at the present time for use in underground coal mines require that a sample be delivered to the detection cell. To overcome this problem the development of a sensor based on LIDAR (light detection and ranging) and differential absorption LIDAR (DIAL) techniques was initiated. A review of these techniques and their applicability and adaptability to measure methane in underground coal mines is completed (DSS Contract #14SQ.23440-4-9278).

Other projects included the determination of the methane content and rates of desorption of coal samples collected at the coalface and an initial investigation of the use of statistical methods to evaluate seam gas content.

LABORATORY AND FIELD SERVICES

The Coal Testing Facility analyzes coal samples for the Nova Scotia Department of Mines and Energy as part of the Joint Federal-Provincial Resource Development Agreement and contributes to CANMET's coal reserve assessment sub-sub activity.

Analysis of Coal Samples

During the year a total of 890 coal samples were analyzed for the Nova Scotia Department of Mines and Energy (this work will continue into the 87-88 fiscal year). This work will be published in a divisional report. In addition, 62 in-house methane desorption samples, several round robin samples and other miscellaneous samples were analyzed.

Canadian Commercial Coals

The Laboratory has completed the CANMET report entitled the "Analysis Directory of Canadian Commercial Coals - Supplement No. 6". This work was done in cooperation with ERL Bells Corners and the report is now available. Plans are currently underway for a sampling program in fiscal year 87-88 with analyses to be included in Supplement No. 7.

Coal Data Bank

A contract for the maintenance of the data bank on eastern coals from Nova Scotia and New Brunswick and a computer simulation program of washplant performances at the University of New Brunswick was introduced during the fiscal year. The Laboratory is presently in the process of transferring this data back to CBCRL and also to the Institute of Sedimentary and Petroleum Geology, GSC, Calgary to be incorporated into a 'Canadian' coal data bank.

Miscellaneous Activities

This Laboratory has developed a computer program which classifies coal according to rank using Method D388-84 of the American Society for Testing and Materials (ASTM).

This Laboratory is represented on the A.S.T.M. Committee D-5 on Coal and Coke; attendance was made at a meeting of this Committee during the fall of 1986 at El Paso, Texas. The ASTM Committee D-5 meetings are an opportunity to continuously improve and to formulate new ASTM standard procedures for preparing and analyzing coal samples. During the fiscal year, this Laboratory has participated in ASTM round robin analyses.

The Environment and Strata Mechanics groups have received considerable support during the year in field data collection and subsequent data analysis utilising the computer facilities available in the Laboratory. The staff has also assisted in software development programs.

OTHER ACTIVITIES

Frictional Ignition Control

The Frictional Ignition Working Group (members drawn from Labour, Management and Regulatory Groups) continued to meet from time to time during the year. From its forum came a proposal for a further and more comprehensive trial of polycrystalline diamond tipped picks. Synthetic diamond tipped cutters display three important benefits in rock cutting applications:

- extremely high abrasive resistance when compared with conventional materials such as cemented tungsten carbide.
- no inherent cleavage planes as in monocrystal diamond.
- self-sharpening properties because of laminated composite structure.

Such properties were considered as likely to decrease the probability of frictional ignitions.

The proposal was taken to tender for the manufacture and supply of picks but suitable terms could not be negotiated for the tipping of pick shanks with suitable polycrystalline diamond tipped faces. The project was eventually shelved.

Further investigation continued on the performance of hollow shaft ventilators using tracer gas techniques to describe the flow distribution and quantities around shearer drums that are produced by hollow shaft ventilators installed in the hollow bosses of shearer drums. The performances were subsequently described for all three operating shearers at Lingan Colliery in a Divisional Report presented to CBDC.

Water Jet/Water Jet Assisted Cutting

The Laboratory maintained close contacts on international developments on the successful application of water jet assisted cutting equipment. Most of the development work during FY 86-87 has been concerned with shearers and has produced some positive results.

CBCRL is informing CBDC of ongoing developments and is actively encouraging CBDC to consider trials with shearers equipped with water jet assist features.

Two further meetings were held with Dr. Peter Wood who is compiling the International Energy Agency's review report on water jet/jet assisted cutting and drilling. A draft of the review report was circulated to CANMET and to CBDC for comment in November 1986. It is expected that Dr. Peter Wood will debrief this report in Sydney during April or May 1987.

The Use of Water for the Suppression of Dust

The evidence is becoming increasingly more convincing that the correct method to suppress the production of airborne respirable dust from the cutting picks that are used on the drum of shearers is to apply water through a nozzle preferably located directly in front of the cutting picks or better still through the bodies of the picks. Water pressure is a critical factor and should be supplied to the nozzles at pressures equal to or more than 6.9 MPa (1,000 lbs/in^2). Water volumes are not increased by the

use of higher pressures as nozzle sizes are proportionately decreased tending to diminish the volumes. CBCRL is providing both information and advice to CBDC on the effective application of higher water pressures.

SURFACE MINING LABORATORY

RESEARCH AND DEVELOPMENT

SURFACE MINING LABORATORY
RESEARCH AND DEVELOPMENT

ADVANCED TECHNOLOGY

The objective of the advanced technology group is to conduct an industry oriented applied research program addressing surface mining methods and systems aspects which offer potential economic benefits to the Canadian surface coal and oil sands mining industries.

The major thrusts of work this year were industrial consultation, technology transfer and a demonstration project. We have promoted enhancement of existing technology and adaptation and acceptance of new technology by the industry through the preparation of concise state-of-the-art reports on mining methods and mining equipment, organization and participation in seminars and symposiums and the demonstration of blast casting technology at Fording in British Columbia.

In house studies concentrated on optimization of production from loading and hauling units from continuous and discontinuous mining systems. The concept of match factor, that is matching of the loading capacity to hauling at all times of the operation, was re-evaluated. The results were summarized in a divisional report and presented in a paper to the Society of Mining Engineers of AIME, U.S.A. in September, 1986. Other completed studies relating to productivity enhancement included the application of bucket wheels to coal mining, design and construction of haulroads, and equipment sizing and selection for oil sands mining.

Considerable effort continues to be directed towards surveying world-wide developments in surface mining production technology. These developments are analysed and those deemed pertinent to Canadian surface mines are documented and resulting reports distributed within the industry. A Wirtgen miner was field tested at a surface mine in Saskatchewan, several mines have installed micro-processor based production and equipment performance data gathering devices on their equipment and computerized mine planning is becoming more acceptable. In addition, three mines are currently investigating the application of high angle conveyors. The Advanced Technology group has prepared and distributed reports on all of these aspects of surface mining technology.

In the area of technology transfer, a major symposium entitled "Geotechnical Stability in Surface Mining" was organized in co-operation with the University of Calgary. A second symposium, "Continuous Mining Systems for Surface Mining", was organized in co-operation with the University of Alberta in Edmonton. Presentations were also made at local chapters of the Canadian Institute of Mining and Metallurgy dealing with the selection and utilization of surface mining equipment.

The demonstration of blast casting techniques is being carried out as a jointly funded CANMET-industry research project at the Fording River surface coal mine in the mountain region of south east British Columbia.

Blast casting as a concept is not new, however, its systematic application in Canada has not been studied in the past. This project's aim is to identify and demonstrate typical mining conditions where this technique can be applied to result in a reduction in material handling costs. To date the results have been promising. Other mines in the region are beginning to consider this technique as an alternative to mechanical means of excavation. A comprehensive report on this topic was presented at the November, 1986 geotechnical symposium held in Calgary.

ENVIRONMENTAL CONTROL

The objective of the environmental control group is to conduct an industry oriented applied research program addressing spontaneous combustion and related aspects of coal handleability.

Progress on the characterization of western Canadian coals with respect to their susceptibility to spontaneous combustion has been considerable. A number of western coals were tested for spontaneous combustion liability by carrying out crossing point temperatures and oxygen absorption tests. Test results were interpreted in terms of coal rank, moisture, volatile matter, carbon, oxygen and exinite content. A detailed report discussing the findings was prepared.

Work was initiated to determine the effect of carbon dioxide saturation for reducing spontaneous combustion liability of stored coal. Preliminary test results proved encouraging but more exhaustive study is considered necessary before any concrete conclusions can be made.

Contract work on the study of spontaneous combustion reaction mechanisms at the University of Calgary was completed. The report discussed the phenomenon of spontaneous combustion with emphasis on western Canadian thermal coals. Correlations between residual moisture content of partially dried coals and their thermal responses to a flowing stream of air in an adiabatic calorimeter have been defined. The thermal response increased significantly as the moisture content of the coal was reduced. When dry air was passed over coal containing varying amounts of moisture, the thermal responses were all negative. As the moisture content of air was increased, the thermal response became increasingly positive. The increase was found greatest with dry coals. The study also indicated that the thermal response was related more closely to the percent of equilibrium moisture than the absolute value of residual moisture. Peroxygen content of coal was found to have an inverse relationship with the rank of coal and in general, partially dried coals showed higher peroxygen content.

A proposal was developed for an automated multisample laboratory spontaneous combustion apparatus to provide industry with a rapid assessment of the spontaneous combustion hazard during mining, storage and transportation of coal. Work was completed on a preliminary design of this laboratory equipment.

Modified oxygen absorption apparatus was established using a 20 litre container for evaluating the spontaneous combustion liability of treated coal obtained from the process developed by Gulf Resources Ltd. Advice and assistance is also being given on a continued basis for stock pile monitoring of the treated coal so that the effectiveness of the process in reducing spontaneous combustion hazard of partially dried thermal coals can be ascertained.

Further cost recovery projects have been initiated to determine methane desorption and spontaneous combustion characteristics of sub-bituminous coals intended for use in power generation.

A paper describing the problems associated with the safe storage of thermal coals and their potential solutions was prepared and presented at the Second International Symposium on Occupational Health and Safety in Mining and Tunnelling held at Prague, Czechoslovakia in September, 1986. The paper was prepared jointly with H. Sahay, Director, Engineering & Mines Branch, Occupational Health and Safety, Alberta.

Work on biological control of methane was continued. Tests on two to three tonne coal samples obtained from the Cape Breton Development Corporation (CBDC) wash plant indicated that bacterial oxidation of methane is possible at that scale. Two thirty litre air lift fermentors were designed and constructed and experiments for optimizing bacterial growth conditions in these fermentors were completed. The work is jointly funded by CANMET, Ship Safety (Transport Canada) and the Cape Breton Development Corporation.

Progress in biological control of methane will be presented at the Ninth International Symposium on the Transportation of Dangerous Goods by Sea and Inland Waterways to be held at Rotterdam in April, 1987. An article is also scheduled to appear in "New Biotech".

A comprehensive environmental monitoring system was installed at the AOSTRA-UTF site during 1986 using a hybrid system proposed by CANMET. Preliminary evaluation of the system identified that malfunctions of some of the components are causing occasional erratic readings. Manufacturers are presently investigating the problem and expect to make the system fully operational in early 1987. So far, spot analysis and the data obtained from the monitoring system have indicated that potentially explosive contaminants are negligible. This may change significantly with the introduction of steam injection in mid 1987.

GEOTECHNICAL ENGINEERING

The objective of the geotechnical engineering group is to conduct an industry oriented applied research program addressing design, monitoring and stabilization of surface coal and oil sands geostructures.

Discussions have been held with coal operators, consultants, universities, regulatory bodies and other research organizations, with a view to identifying research requirements, setting research priorities, developing jointly funded cooperative research projects, enhancing technology transfer and utilizing the available geotechnical research expertise and resources in the best possible way. A discussion document was produced and circulated to all concerned. This approach was found to be very effective in developing research plans in general and highlighting immediate research needs in particular.

A jointly funded cooperative research project was developed with TransAlta Utilities Ltd. to develop a finite element computer model based on the stress-property-deformation-relation (SPDR) technique for TransAlta's Highvale Mine. The SPDR model considers the rheological characteristics of the rock mass and uses in-situ rock stress and properties which enhance the reliability of prediction. Field tests were carried out with the S-100 Stressmeter and P-100 property meter. Geotechnical, geological, hydrogeological, downhole geophysical and ground deformation data as well as special laboratory rock property test results are also being fed into the model which will be completed and validated next year.

Work was continued by external contract to upgrade the CANMET tiltmeter/radio telemetry monitoring system in cooperation with Syncrude. The system has been modified to accept slope inclinometers and transmit data extended distances (plus 5 km) and is currently in use at the Syncrude mine site where it is monitoring dragline working bench movements.

Using geotechnical data collected from the footwall at the Line Creek Mine, Sparwood, B.C., a contract study has investigated exploration techniques, monitoring methods, analytical design methods, operational constraints and other factors affecting steeply dipping footwall stability in mountain regions. The critical parameters for the stability of a footwall have been identified, and innovative methods of analysis have been developed, particularly with regard to the analysis of buckling failure of curved slabs. The final report includes the following: a program called CURVBUCK for analyzing curved slopes subject to buckling; other analytical methods for studying plane slopes subject to buckling; confirmation of the presence of high horizontal stress in a surface coal mine in the Rockies; monitoring of footwall movements and design charts for various stability models.

A major research investigation is being undertaken by the Alberta Oil Sands Technology and Research Authority (AOSTRA). They have developed an Underground Test Facility (UTF) for evaluating the feasibility of bitumen recovery from deep oil sands through the "Shaft and Tunnel Access Concept." Horizontal boreholes drilled from an underground tunnel will be used to inject steam into the tar sands and create steam chambers. Mobilized bitumen will be collected in other horizontal parallel boreholes located at a lower horizon in the tar sands.

CRL has been working closely with AOSTRA to develop a geotechnical monitoring program for the UTF steam injection experiments. Geotechnical instrumentation will be installed in the roadways and shafts of the UTF and in the strata and soil around the steam chambers. These will be monitored for the duration of the steam injection. This will cover the time during which the steam chambers are formed, their active production lives, and the chamber blowdown period.

Data gathered during this study will be used to monitor the integrity of the underground openings and comprehend the mechanisms of the rock and fluid movements in and around the steam chambers. This data will ultimately be used to simulate the effects of the steaming process with a numerical model or models. The benefits of this will be a possible improvement in the optimization of the extraction process (in a similar manner that reservoir engineers use models in conventional oil field recovery) and a control mechanism for ensuring protection of the environment (eg. prevention of aquifer contamination or destabilization of the underground openings).

The mining industry has identified the need for additional information on the physical characteristics of overburden to aid in mine planning and design. The high costs of conventional drilling programs, however, discourage extensive pre-mine investigations. A jointly funded project (50/50) proposed by an industry consortium has been initiated through a research contract that continues into next year. The objective of this study is to develop and improve the application of downhole geophysical techniques for characterizing overburden in the oil sands mining regions of Alberta.

All seven coal producers in British Columbia, the B.C. Mining Association and the Canada-British Columbia Mineral Development Agreement have collectively funded a research study to investigate the stability of coal mine "live" waste dumps. This work documents and consolidates the current state of the art of the behaviour of such waste dumps. CANMET participated in this project by providing the incremental funding necessary to permit a comprehensive data analysis of the complete monitoring records of the "live" dumps maintained by the seven B.C. producers. In a separate but related area, discussion between Smoky River Coal and the laboratory have outlined a cooperatively funded project to study the dynamic stability (effects of blasting vibrations) of a marginally stable waste rock dump next year.

OPERATIONS RESEARCH

The objective of the operations research group is to conduct an industry oriented applied research program addressing computer simulation methods, related field data collection requirements and associated technology gaps that provides industry with practical short term production scheduling assistance.

System analysis is the identification of the logic structure of the activity being studied. For example, if the activity of interest is the operation of a dragline, a flow diagram can be constructed for activities such as cast, swing, walk, etc. from which the conditions under which the dragline will make a choice (e.g. to walk to a new position), may be determined. Each of the sub-activities may be again subdivided. Thus, the swinging action of the dragline may be considered alone and may be described with equations based on the moment of inertia of the dragline and the accelerating and decelerating torques. When more than one device is involved in an activity, the nature of the interaction must be accurately identified, e.g. the interaction of trucks with shovels.

Data gathering and time studies of mining equipment must be completed before computer simulation can begin. Some of this data, such as equipment specifications is readily available and can be compiled in computer data bases for easy accessibility. However, there are less well defined parameters for which data must be gathered and analysed; for example, the derating of equipment performance due to age, climate or altitude. Mine operators often do not have the equipment or facilities to measure these factors and consequently they have to rely on the subjective estimates of their experienced personnel. Hence, mine planning becomes less precise.

Computer modelling provides a management tool to predict the effect of changes to an existing operation or the productivity of a new operation. The modelling programs obtain data both from the user and from the data files stored in the computer memory. An important distinction between models is between deterministic models and stochastic models. A deterministic model uses input data and can be thought of as a series of calculations. A stochastic model randomises certain parameters and thus does not give exactly the same answer each time. A deterministic model is used

to determine the time taken for a truck to travel between two points, however, when an entire fleet is to be modelled by an "event-based" model, travel times are presumed to have a statistical variation about a mean.

Validation implies proving the correctness and accuracy of the model by comparing its results with field data. Clearly the field data used here must be for different cases than were used for the initial construction of the model. There will inevitably be differences between the predicted and observed values and these need to be assessed and where possible explained and minimized by "tuning" the model.

A steady-state computer model of truck/shovel operation was developed jointly with the National Research Council of Canada and tested using data from eight surface coal mines in western Canada. The model results were also compared with the results generated by other models, such as mathematical models from truck manufacturing companies. The model was also presented to the various mining companies for their in-house evaluation. A new DATAENTRY package that contains specifications of off-highway trucks, loading equipment and other specific constraints was added to the original model structure.

A contract to validate an event-based model of the bucket wheel excavator-conveyor-bin system was completed. Additional work on this model will depend on finding an industrial partner to use this model and provide data for further validation purposes.

A dragline model to calculate range diagrams and to provide an optimizing tool for various dragline methods was added to the models of mining equipment used by the Laboratory. The model was tested using data from Pit 4, Highvale Mine. Work is planned to incorporate this package into the overall scheme of computer modelling packages that are under various stages of development by the group.

A joint co-operative project with Obed Mountain mine to develop a computer model of "Easi-Miner" was initiated during the year and the first version of the model simulating production of "Easi-Miner" and hauling equipment was presented to the mine. As a part of the study, extensive time studies of the operation were performed.

A jointly funded demonstration and evaluation of an integrated truck management system commenced with Gregg River mine at their property

near Hinton, Alberta. A commercially available on-board data acquisition system (OBDAS) was selected and is presently being tested on two 154t. haulers at the mine. The demonstration of the system is expected to enhance operational awareness of truck performance, resulting in improved management information and control which will lead to improved vehicle fleet productivity and reduced cost. The assessment of the system includes:

1. an evaluation of the reliability, accuracy and utility of the various system components, and
2. a comparison of system generated data with visual time study collected data,
3. an assessment of the significance of the outputs to enhanced productivity/reduced operating costs, and
4. an overall review of the six months trial including emphasis on problems and successes of the work.

The operating costs of a mine haulage fleet are a significant proportion of total mine operating costs. The condition of mine haulage roads has a strong influence on the productivity of mine haulage fleets and hence the operating cost at the mine. To determine the most economical expenditure on haul road construction and maintenance requires detailed knowledge of mine haul road rolling resistances. Known methods of measuring rolling resistances require two trucks, one to pull the other. This method is expensive (due to lost productivity of the trucks) and consequently rolling resistance measurements are seldom conducted. To overcome these difficulties an instrumented trailer has been designed and constructed that can measure rolling resistances when towed by a 3/4 ton truck equipped with an automated data acquisition system. This trailer is now operational and will be used to survey mine road conditions and to examine various road construction methods that may improve rolling resistance.

A proposal has been prepared to construct a new radio data transmission system. The new system will greatly enhance data transfer protocol and thus enable a wide variety of applications including simple interfacing with most intelligent devices. Examples of applications include the transfer of dragline data in real time to the mine office, communication with truck management systems and basic hardware for a truck dispatch system. When integrated into an equipment monitoring system the telemetry will give

instant information to engineering and management and remove the task of downloading data from the monitoring device to the mine computer.

A programmable data-logger (Omnidata's Polycorder) is currently in use on two projects: to carry out a time study of the "Easi-Miner" and to measure the dynamic forces required to tow a mine truck, and hence derive the rolling resistance values.

Several software packages were prepared and documented in-house during the last year. Most significant are digitizing programs to generate input data for a haulage simulation model by map display program software for VT 240 and Vax Station 100 graphic screens, digitizing software to reproduce images into a data files for the haulage simulation program, grapher program software for normal distribution, linear regression, and multiple lines on the same graph, overhead creation programs for graphic presentation using VT 240 terminals, and software to evaluate data and produce Weibull type distribution graphs.

One novel alternative of approaching simulation and dispatching of truck at mine sites is to use the Prolog programming language to treat the dispatching problem by using an "expert system" or a "knowledge engineering" system. Introductory work on truck dispatching (numerical optimization versus knowledge engineering) was completed. Such an approach stresses the complex nature of optimal dispatching policies rather than taking a numerical optimization approach.

RESERVE ASSESSMENT

Within EMR, the Institute of Sedimentary and Petroleum Geology (ISPG) of the Geological Survey of Canada has responsibility for coal resource assessment, and the Coal Research Laboratories of CANMET is responsible for coal reserves, including commercial coal quality. At CRL's initiative three meetings were held with officials of ISPG to ensure some coordination between respective work plans. It was agreed CRL and ISPG would collaborate on creating and maintaining a coal quality data file which would hold information on both resource quality and reserve/production coal quality. It was also agreed that ISPG and CRL would jointly produce an EMR publication on Canada's coal resources and reserves in 1990. Currently, official updates are being presented in separate manuscripts. ISPG's "black

book" will update the national resource picture as published in EMR report ERP 79-9 "Coal Resources and Reserves of Canada" (December 1979) and a CANMET report "Coal Mining in Canada, 1986" will update official reserves as published in CANMET Report 83-20E "Coal Mining in Canada: 1983" (April 1984).

CANMET Report No. 85-11E "Analysis Directory of Canadian Commercial Goals: Supplement No. 6", released in January, 1987 presented coal quality data based on a national sampling program in 1984. For the first time this report series included the trace elements chlorine and fluorine. Further disclosure of other trace elements in Canada's commercial coals is under discussion with the Coal Association of Canada.

During the past year the Coal Association of Canada reactivated its Working Group on Coal Resources and Reserves, including its sponsorship of the "Resources and Reserves Reporting Seminar" in Calgary on 20 November, 1986 where we presented a paper on coal reserve assessment in EMR. This seminar, which had 50 registrants, proved to be a useful forum for discussing issues of methodology in assessing coal from the points of view of coal operators, provincial coal officials from British Columbia and Alberta, and from EMR. The basic differences between EMR and Alberta's Energy Resources Conservation Board on reporting resources/reserves of coal for Alberta are still under discussion.

Along with the areal extent and thickness, in-situ coal density is basic to calculating tonnages of coal reserves and resources. There is no standard field method of determining this factor and there is a general dearth of reliable data as regards various coal ranks in western Canada. A contract was issued during the year to critically assess current techniques and gauge the interest of coal operators in a possible cooperative field testing program.

Because of the projected over-supply of coal and the emergence of increasingly strict product specifications, transportation costs, and other strategic issues as barriers to the expanded use of Canadian coals, there is a need to shift the emphasis of our reserves assessment work. Reports on Canada's coal reserves will now be published only every four years and this will be done jointly with the GSC. Canada's supply of various ranks of coal for various domestic and export markets is assured for the long term at current production levels. The reserve inventory will be kept current by

systematic visits to mine sites and regular contacts with provincial and industry officials.

There is a need for strategic studies to be done in consultation with industry and provincial coal officials aimed at enhancing the marketability of Canadian coals. One such study relates to coal transportation, as transportation costs have been identified as a major barrier to expanded use of western Canadian coals.

Another strategic study will identify which minor and trace elements - including radio-active minerals, are of major concern to users of Canadian coals. Those coal reserves which appear to possess an advantage over other competing coals or fossil fuels will be identified by coalfield. Other studies will be undertaken so as to exploit any inherent advantages of Canada's commercial coals. For example, their amenability to new process technology such as deep cleaning or rank upgrading. This characterization is at a more sophisticated level than conventional physical, chemical and petrographic analyses.

Such strategic studies will identify short, medium and long term industry needs and research opportunities that hold promise in reducing the delivered cost of coal and enhancing Canada's reputation as a supplier of high quality solid fuels.

FUEL PROCESSING LABORATORY
RESEARCH AND DEVELOPMENT

FUEL PROCESSING LABORATORY
RESEARCH AND DEVELOPMENT

CARBONIZATION UNIT

The main function of the Carbonization Unit of the Fuel Processing Laboratory (FPL) is to perform pilot and laboratory scale carbonization tests on Canadian metallurgical coals and their blends. This function is necessary in order to conduct coal/coke evaluation and improve the marketability of Canadian coals. The latter is especially important to western Canadian coal producers who are facing increased competition due to soft international markets and underestimated western coal potential by conventional resource evaluation methods.

The main activities of this unit are performed in cooperation with the coal and steel companies through the Canadian Carbonization Research Association (CCRA). The FPL Carbolite pilot scale coke oven together with its auxiliary facilities is one of the three testing coke ovens in Canada.

Coal/Coke Evaluation

Metallurgical coke must possess certain properties in order to fulfill its functions as reducing, carburizing, and structural stabilizing agent in the blast furnace during the iron-making process. Coal/coke evaluation involves the assessment of these coals for coking and caking properties. This demands an in-depth physical, chemical and petrographic analysis as well as measurement of rheological properties.

In the fiscal year 1986/1987, fourteen cost recovery carbonization projects (involving coal/coke evaluation) were successfully carried out and completed.

Comparison Between High Drop and Normal Charging Height

The influence of the height of the charging hopper on coke quality was investigated. All coal charges were studied under the same standard heating profile, size and bulk density. Two coal charges were run with a normal charging height as control. The charging height was increased - for two experiments - to 10 meters. A comparison between these tests shows that a high charging height improves the coal/coke properties as measured by coal charge bulk density and coke strength.

The Influence of Carbonization Time on Coking Properties

Coke properties can be enhanced by optimizing oven operating conditions. Longer coking time can improve coke properties at the expense of energy/time consumption. In this study the influence of coking time on coke properties was investigated.

The Eurotherm 821 controller/programmer interfaced to the CRL carbolite coke oven was used to generate a variety of heating profiles from which the desired coking rate of coals was determined. The results obtained show that by decreasing the coking rates of the coal, coke strength was improved by as much as ten units measured in term of the ASTM stability index.

Reproducibility of the Coke Oven Testing Program

In order to ensure that the same standard specifications are maintained for all the operating coking ovens, a Round-Robin testing program was setup to examine the reproducibility of the coke ovens in Canada (Devon and Ottawa). Using the same coal blend, each coking oven was tested under standard coking conditions and the results collected for comparison purposes. The findings were presented at the 113th C.C.R.A. technical meeting.

A Study of Coal Contamination with Rust

The presence of contamination in coal can produce side-effects resulting in inferior coke quality. The Carbonization unit was asked by a coal company to confirm whether or not rust contamination could result in inferior coke at their plant. Studies carried out at the Carbonization Unit did show that the addition of rust to a rust-free coal sample results in lower coke quality as determined from CSR, coke strength and size consistency data. In another test, the coal preparation process at CRL was tested for rust contamination.

Thermal Rheological and Coking Test on Oxidized Coal

The oxidation of coal affects the overall coking properties of coal such as coke strength, apparent specific gravity and so on. In order to study these effects at the plant level, both thermal rheological and coking tests on slightly oxidized and fresh coal samples were carried out.

The results show that, while the thermal rheological testing process is sensitive to the level of oxidation, no significant change on the coal/coke qualities of these particular coal samples were observed by the coking tests.

COAL PREPARATION UNIT

Beneficiation of Fine Coal

Recent decreases in coal prices has encouraged coal operators to search for means to improve recovery of fine coal and in turn reduce costs. Interest was directed toward spirals due to their successful application in other countries. The Fuel Processing Laboratory carried an experimental study to evaluate the feasibility of using spirals to improve the recovery of fine coal. Spiral performance was compared with water-only cyclones that are presently used. Operating parameters of two types of spirals were examined and compared with those of the water only cyclone. Several advantages of using the spiral were indicated. However, the study also showed that, for certain coals, using cyclones or combination of cyclones and spirals can help achieve the optimum recovery depending on fine particles washabilities.

Characterization of Canadian Magnetite Resources for Optimum Utilization in Coal Heavy Medium Processes

A research contract was completed last year to determine magnetite losses, magnetite sources, characteristics and costs. Several companies involved or interested in the development of magnetite deposits in Canada requested and received information on this study. Furthermore, coal companies received the report dealing with experimental procedures to characterize magnetite as well as the results of a survey on the use of magnetite in their plants, magnetite losses, and means to minimize these losses. As a result of this study, the department of Mineral and Process Engineering at University of British Columbia started a research program on magnetite use in coal preparation.

Recovery of Coal from Elkview Plant Refuse by Using Spirals

Based on experience gained in evaluating spirals, a project was carried out on refuse samples from a western Canadian coal-preparation

plant. The objective was to evaluate the performance of a spiral in recovery of clean coal from refuse and intermediate products. The results indicated that the addition of spirals could improve the recovery of fine coal and produce refuse with acceptable ash content. Several options to include spirals to the plant circuit were recommended.

Coal Slurry Pipelining

The Canada/Federal Republic of Germany Memorandum of Understanding on coal slurry systems has supported four areas of cooperative activities:

a) Dense Coal Slurry Systems The Alberta Government is interested in continuing the activity as a potential alternative for the transport of Alberta coal to Ontario. Current activities with Smokey River, who cooperated earlier in the testing program are now completed.

b) Coarse Coal Slurry Short Distance Pipelining The German's contribution to the coarse coal slurry pipelining program was complemented by the work carried out by the Saskatchewan Research Council (SRC).

c) Manual of Design for Slurry Pipelines An engineering manual for the design and construction of coal slurry pipeline has been completed by the Saskatchewan Research Council. The manual was made available to the German side as part of the Canada contribution to the cooperative program.

The status of the cooperative program will be reviewed during the planned meeting in Ottawa on June 1987.

Process Control Applications

Industry Survey To consolidate CRL programs on coal preparation process control development an industry-wide survey was conducted with two main objectives:

- identify industry needs and problem areas
- generate industry feedback as a reference point in CRL's planning and overall strategy.

In general, all the respondents were in favour of pursuing process control R&D. Froth flotation circuits were the highest priority for process control development, followed by thermal driers, thickeners and jigs.

International Process Control Development - An Evaluation To complement the national evaluation of coal preparation process control, an international evaluation of new developments in the U.K. and West Germany (two of the leading countries in process control R&D) has been conducted through visits to recognized research centres and industrial plants.

Heavy Medium Control System The heavy medium density control system was successfully completed with acceptable response time. However, the developed system will be the focus of future improvements especially in the control algorithm to achieve superior response time. The complete design for control (completed last year) will be the focus of implementation in CRL pilot plant facilities.

Off-line Process Control Development Work on coal blending has been completed and presented at the 10th International Coal Preparation Congress, Edmonton, 1986. The research work provides graphical and numerical techniques to determine the optimum separation cutpoint. Three aspects of this problem were considered: blending of raw coals, blending of washed coals and blending of raw and washed coals. A superior numerical technique utilizing signal flowgraph was completed to produce information on specified quality products. The results were presented at the 3rd Conference on the Use of Computers in the Coal Industry, held in Morgantown, West Virginia, July 1986.

Industry Technology Review During April-May 1986, twelve coal preparation plants were visited. The objectives of these visits and discussions with plant superintendents were to obtain feedback from industry on several areas specific to coal preparation: mobile fine treatment plant, deep cleaning and coal-water mixtures technology and process monitoring and control. It was appropriate to obtain industry viewpoints on operating problems, present and planned CANMET programs and capabilities and last but not least to establish and renew personal contacts. The response of operational management can be summarized as follows:

1) The fine treatment mobile plant (froth flotation and spirals) should be modified to operate as separate units within the host operating plant.
2) The deep cleaning and coal-water mixtures technology program should be supported as a long-term project.
3) Since process control reflects the need for accurate and reliable process monitors, control strategies are needed for processes such as froth flotation in order to improve and optimize recovery.
4) The main operational concerns and interests were handling, processing of fines, dewatering of fines and handleability (dust and freezing problems).

FOSSIL FUEL SCIENCE AND APPLICATIONS UNIT

This section is intensively involved in both collaborative cost-recovery industrial research as well as laboratory-based fundamental support studies. These latter studies are based on industry needs and problems as determined by continuous consultation with a wide range of industry representatives and plant site visits by research scientists.

During the 1986/87 FY, cost-recovery activities in the laboratory comprised such areas as oxidation and weathering of stockpiled coal and related effects on flotation/beneficiation/coking properties, low rank coal upgrading, char evaluation, characterization of pitches, oil sands tailings pond emulsions, demulsifier identification, modification and testing (in-house and field) and characterization of heavy oil natural surfactants. The success of cooperative multi-disciplinary research in solving practical industry problems has attracted considerable industrial as well as national and international recognition. Extensive contacts have been made with heavy oil and coal processors, chemical manufactures and intermediate businesses (i.e. suppliers of chemicals to the industries in question). These efforts were a significant component of the group's efforts and resulted in about 20 confidential reports.

Coal and Oil-Sands Microstructure

The techniques available in the microstructure laboratory, including scanning electron microscopy, mercury porosimetry, surface area measurements and gas sorption/desorption (ΔP) studies, have been used in the

on-going study of coal weathering/oxidation and low rank coal upgrading. Coal oxidation impacts on many aspects of both coal beneficiation and utilization, including froth flotation, coking properties, and coal dustiness. The commercialization of the ΔP instrument developed at CRL reflects the transfer of technology to industry. As a consequence of past efforts, the construction and installation of a low rank coal upgrading reactor facility is underway.

The cryogenic capability of the scanning electron microscope has been further developed and utilized in several projects concerning oil sands emulsions. Both morphological studies and the x-ray fluorescence analysis capabilities allow determination of emulsion structure and composition, including detailed elemental analyses of continuous and dispersed phases as well as the interfacial region primarily responsible for determining the overall emulsion stability. Extensive in-house work has been directed at optimizing this latter technique and a number of publications in the open (refereed) literature have resulted. The success of these microscopic/image analysis-based projects has resulted in considerable interest among industrial clients in acquiring their own systems for process and quality control in consultation with staff members. Extensive microscopic studies of emulsion aging effects have also been undertaken to ensure that both fresh and aged emulsion behaviour are fully understood in the context of all related in-house and field studies. Group efforts have been successful in expanding industry-government cooperative ventures and several joint publications arising from these research efforts are planned.

Fine Particle Electrokinetics

Research was concentrated on colloidal science aspects of practical systems, such as surface charge densities of high sulphur coal, oxidized and unoxidized coal, run-or-mine, and processed coal using a PenKem 3000 electrokinetic analyser.

A major area of study concerned emulsion stability as related to electrokinetic and interfacial properties of solids derived from heavy oil/bitumen emulsions.

Thermal Analysis Techniques

Several methods of thermal analysis, available in this group, have been applied to a range of practical problems, including: the mechanisms of the thermal degradation of flocculants, the use of thermogravimetric analysis and differential scanning calorimetry to characterize oil sand extracted solids for clay mineral, heavy metal mineral and organic matter contents, characterization of coal with regard to heat content, proximate analysis, and oxidative reactivity, and determination of heat capacity of minerals. One project involved measurement of reactivity of Alberta limestone, which is used as an absorbent of H_2S and SO_2 in a tar sands cracking process. Correlation of thermal analysis data with other analytical techniques has enabled industrial problems to be diagnosed more accurately at less cost than previously possible.

Nuclear Magnetic Resonance Spectroscopy (NMR)

NMR is applied extensively to the study of fossil fuels and polymers. Fundamental and applied studies involve low rank coal upgrading processes, natural and low temperature (laboratory) oxidation and weathering, maceral characterization and relationship to whole coal properties, and a survey of functional group distribution in coals of most ranks. Polymer applications include flocculation and demulsification mechanisms, polymer characterization (lot-to-lot variations), thermal stability, and charge density and charge distribution of flocculants and demulsifiers as correlated with field determined efficiencies. Other research involves the relationship of clay mineral composition with flocculation processes in washeries, characterization of insoluble organic carbon associated with clay minerals and heavy metal minerals in oil emulsion treatment and heavy oil upgrading processes. We have been able to determine the mechanisms of low rank coal upgrading as well as the mechanism of low temperature oxidation of high rank bituminous Alberta and British Columbia coals. In addition, a comprehensive understanding of the origin of stable water-in-oil emulsions in refined oil sands plant products has been developed in collaboration with the industry.

Emulsion and Flocculation Studies

Additional demulsification work not noted in other sections has involved screening of novel chemicals for oil-in-water and water-in-oil

demulsification. Refinements in test procedures and methods of analysis have also been investigated. Collaborative research regarding improvement of flocculants (with both chemical manufacturers and coal industries) has also been undertaken.

Raman and Infrared Spectroscopy

Raman spectroscopy has been applied in two principal areas. The first, a study of structure and spectra of clay minerals as part of an on-going investigation of the interaction between clay minerals and organic compounds. These systems are encountered frequently in industrial samples, e.g. clays extracted from tar sands. Surface-enhanced Raman spectra of acrylamide, polyacrylamide, and acrylic acid have been obtained; this area of research has helped to elucidate the mechanism of polymerization, the long term objective being control of polymer characteristics through the polymerization process.

The second, Fourier Transform Infrared (FTIR) spectroscopy, has been applied to the characterization of a variety of fossil fuel samples, including coal macerals, whole coals of various ranks, lignites (including changes brought by upgrading), peat, pitches, and others. The photoacoustic detection technique has been developed further and applied to the study of fossil fuels, minerals, and polymers. A significant amount of industrial work has involved characterization of samples. Results obtained from FTIR spectroscopy continue to be correlated with those from NMR, SEM, thermal analysis, and other techniques available to ECRL. Capabilities were significantly enhanced through the installation of a Circle Cell enabling aqueous solutions to be conveniently studied by IR. Negotiations with an instrument manufacturer will enable FPL to obtain the prototype of a novel IR interferometer - the first of its kind in the world. In-house testing will involve novel applications to existing industrial problems noted elsewhere in this section.

Optical Microscopy

Industrial applications of image analysis in general and optical microscopy in particular have been exceptionally well developed during the year, with the main focus on industrial water/oil and oil/water emulsions.

Observation of selective wax deposition/crystallization in crude oils by variable temperature/fluorescence microscopy has been undertaken. Optimization of the Cambridge Quantimet image analyzer has been undertaken to provide quantitative analysis of submicron particles. Correlations between particle size and effect of caustic and demulsifier concentration have been investigated to support optimization of heavy oil upgrading processes. Particle size analyses, ion chromatography, gas/liquid chromatography, interfacial tension, contact angle, Dean and Stark analyses and moisture meter measurements were also indispensible components of all programs noted.

ENGINEERING AND FIELD DEMONSTRATION UNIT

Heavy Oil/Bitumen Emulsion Treatment Plant

In the in-situ recovery of bitumen, the formation of oil-water emulsions presents a serious problem. The necessity of separating such emulsions arises from environmental concerns and from the need to maximize product yield. One aspect of activity in this field is a 70 barrel/day emulsion treatment mini-plant, which will include oil-water separation equipment such as a free water knockout vessel, dual polarity electrostatic treater, evaporation dehydrator, induced gas flotation unit, and others. The mini-plant is under construction with completion scheduled by the end of summer and preliminary testing in the fall of 1987.

Mobile Dewatering Plants

The mobile dewatering plants were field tested at one washing plant. The purpose of this field testing was to make fine adjustments in the operation of belt filter press and to optimize the process conditions. The results obtained have provided better understanding of the dewatering process and indicated the areas for improvements which will improve the machine operation and reduce chemical consumption. Last year the disc filter was loaned to Luscar-Sterco Ltd. for dewatering the product from oil agglomeration/flotation test program at their coal valley wash plant. The disc filter was installed in the trailer and field tested.

Mobile Water Treatment Plant

The mobile water treatment plant was used in one washery with objective of optimizing flocculant application to improve the performance of

the water treatment circuit. The purpose of this field testing was to evaluate the performance of potential flocculants and rank them on cost and performance basis. As a result of this field testing, the washery has requested CRL to provide assistance during full scale plant trials of the selected flocculants.

PROCESS CONTROL AND COMPUTER APPLICATION UNIT

Work of the Unit proceeded along theoretical and applied fronts in the areas of process modelling and monitor development. There was participation in the planning stages of several cost-recovery projects with industry through advising and assisting in the design of experiments related to water treatment and agglomeration studies. At the request of industry, consultation with recommendations based on statistical analysis of submitted data, were provided on the reliability of their coal analytical methods and procedures.

Process Modelling

In addition to on-going programs, the modelling effort saw the initiation of studies on the kinetics of coagulation processes by computer simulation techniques and on the fractal geometry of coal and coal product particle surfaces. Although in its early stages, the latter study has yielded a fractal dimension for some sub-bituminous coals which will be further investigated as it relates to various practical indices such as friability, dustiness, reactivity, etc. of the coals or their products.

Answers to questions regarding mechanisms of flocculation of colloidal particles by water-soluble polymers are vital to establishing a much-needed scientific basis enabling optimized design, selection and application of such polymers in solid-liquid separation processes. A critical review and analysis of the literature showed no experimental evidence to clearly favour either the "bridging" or "charge-patch" models over the other. The problem appears to have arisen from the fact that there has been no consistent approach to resolving the question and that the reported investigations have focussed on as many different systems as there are researchers.

Analysis of water treatment mobile plant field test results led to a number of recommendations to improve the mechanical and operational capabilility for data gathering. Among these improvements were completing the installation of monitors and a change in the thickener underflow pumping system. The latter change would be to allow implementation of a greater range of flowrates using either continuous or intermittent pumping regimes as required for process optimization. The test results also showed that the rate of reagent addition needed to maintain clarity generally became increasingly greater as the percentage of minus 44 micron fines in suspension increased. For the system under study, it was indicated that in the neighborhood of 60% fines, maintaining clarity could become exceedingly difficult and costly since at that level the effect of reagents was greatly reduced. The field work raised several questions requiring laboratory investigation. One pertained to the adequacy of the "Wedge" which is commonly used as a turbidity monitor for water treatment control in washeries; there was no clear relationship between the Wedge reading and the suspended solids content in the thickener overflow. As a consequence, the danger exists of erroneously increasing reagent dosage when in fact it would not be necessary to do so.

Instrumentation Development

As part of its ongoing program of developing suitable monitors for application in the fossil fuel processing industries, the Unit completed its technical evaluation of a commercial Cs^{137} γ-ray on-line density meter. It was found that the average meter response was linear and reproducible for closely-sized coal slurries in the test range of 1 to 20% solids by weight. However, it was determined that the attenuation of incident radiation by absorption was highly sensitive to particle size of the suspended solids and less sensitive to the solids concentration. Since the meters are not equipped with automatic compensation for particle size variation, this should lead to significant loss of accuracy with such variations. Because of the wide fluctuations in slurry properties, common in coal washing operations, there would appear to be a need for further study and development work to enhance the utility of γ-ray meters for general purpose monitoring in coal washing plants.

Results of the technical evaluation of a Micro-motion mass flowmeter showed that the meter was generally highly accurate and dependable for monitoring water flow. For reasons as yet unknown, its performance with anionic flocculant solutions showed systematically increasing departures from the calibrated output with increasing anionic charge of the dissolved flocculant. For a 50% hydrolyzed flocculant, response was highly erratic at all but the lowest flowrates. Whilst this flowmeter would be generally very reliable, has many advantages and is well-suited to many applications it is apparent from the study that caution would be needed in considering its application to flocculant monitoring. For this use, a magnetic flowmeter was found to give good linearity and consistency of measurement. A limited number of tests on this flowmeter showed every indication that it would give reliable and trouble-free operation for slurry applications.

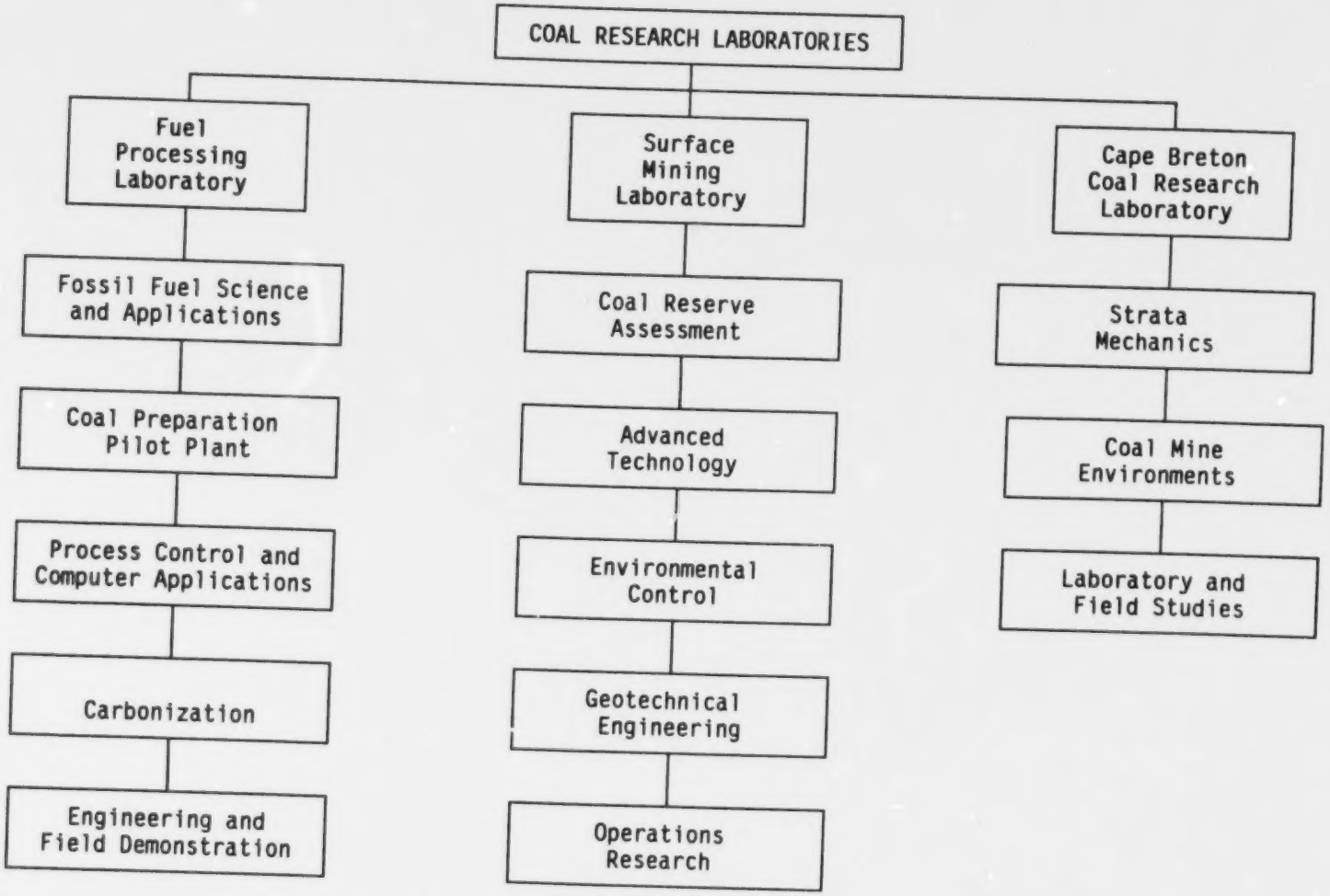
The contract program related to development of electromagnetic (non-radioactive) sensors for phase concentration monitoring in coal-water slurries and oil-water emulsions was delayed.

Computer Applications

Continued assistance to both Administration and to Laboratory R&D programs was provided by way of special applications software development and installation along with instrument interfacing.

The move of the Calgary mining group to the EMR Devon premises in mid-year resulted in a significant effort that was given over to the installation, maintenance, networking and related purchasing for the mining computer system in addition to file transfers and provision of numerous consultation services.

APPENDIX A: THE ORGANIZATION OF THE COAL RESEARCH LABORATORIES


COAL RESEARCH LABORATORIES
Fuel Processing Laboratory
Fossil Fuel Science and Applications
Coal Preparation Pilot Plant
Process Control and Computer Applications
Carbonization
Engineering and Field Demonstration
Surface Mining Laboratory
Coal Reserve Assessment
Advanced Technology
Environmental Control
Geotechnical Engineering
Operations Research
Cape Breton Coal Research Laboratory
Strata Mechanics
Coal Mine Environments
Laboratory and Field Studies

APPENDIX B: RESOURCES

RESOURCES

The 1986/87 activities of Coal Research Laboratories were carried out under both the Petroleum Supply and Coal Technology sub-activities of the Mineral and Earth Sciences Program. The resources allocated to the division were distributed as shown below:

	Staff Level (PY)	Budget ($000's)	
		Operating	Capital
Bitumen/Emulsion Treatment	5	255	200
Coal Preparation	13	361	478
Carbonisation	5	50	10
Coal Reserve Assessment	5	35	0
Coal Mining: East	10	280	188
Coal Mining: West	12	130	86

These resources were distributed across three operating laboratories:

Devon : Fuel Processing
Devon : Surface Mining
Cape Breton: Underground Mining
Devon : Administration

APPENDIX C: PROFESSIONAL, TECHNICAL AND ADMINISTRATIVE STAFF

PROFESSIONAL, TECHNICAL AND SUPPORT STAFF

Name	Degrees and Diplomas	
T.D. Brown	B.Sc. (Durham), Ph.D. (Sheffield), C.Eng.	Director
S.D. Ludwar		Secretary
ADMINISTRATION		
C.F. Cameron		Admin. Officer
C.B. Ripper		Clerk
V. Keim		Clerk
J. Young		Clerk
S. Iwaskow		Clerk
J.I. MacDonald		Clerk
B. Bresson		Clerk
COAL MINING RESEARCH		
D.B. Stewart	B.Sc., M.Sc. (Queen's), P.Eng.	Manager
H. Brown		Secretary
CAPE BRETON		
G.A. Haslett	B.Sc. (Durham), C.Eng., P.Eng.	Group Leader
C. Spitieris		Secretary
Strata Mechanics		
P.R.M. Cain	B.Sc., Ph.D. (Cardiff)	Res. Sci.
T.R.C. Aston	B.Sc. (Cardiff), Ph.D. (Nottingham)	Res. Sci.
Coal Mine Environments		
J.C.Y. Hwang	B.Sc. (Taiwan), M.Sc. (Central) M.Sc., Ph.D. (McGill)	Res. Sci.
B.W. Konda	B.Eng.(Hyderabad), Ph.D.(Nottingham)	Phys. Sci.
D.J. Kennedy	B.Sc. (Windsor)	Phys. Sci.
G.W. Klinowski	M.Sc. (Silesian Tech.)	Engineer

Laboratory and Field Testing

G.W. Bonnell	B.Sc. (Dalhousie)	Chemist
D.J. O'Brien		EG-ESS
D.A. Young		EG-ESS
G.R. Corbett		EG-ESS
W.D. Gallant		EG-ESS
L.S. O'Leary		EG-ESS
C. MacNeil		CS

SURFACE MINING LABORATORY (Devon, Alberta)

Environmental Control

R.M. Chakravorty	B.Ch.E. (Jadavpur), Ph.D. (Nottingham)	Res.Sci.

Operations Research

G. Zahary	B.Sc. (Alberta), M.Eng. (McGill), P.Eng., (On secondment to Program Office)	Phys.Sci.
V. Srajer	M.Sc. (U. of Appl. Sci., Kosice), P.Eng.	Engineer
J. Szymanski	M.Sc., Ph.D. (Wroclaw)	Res.Sci.
R.J. Kolada	B.Sc., Ph.D. (Nottingham)	Res.Sci.
N.J. Stuart	B.Sc., Ph.D. (Nottingham)	Res.Sci.

Laboratory and Field Services

G.H. Larocque		EG-ESS
K.L. Kar		EG-ESS

Advanced Technology

R.K. Singhal	B.Sc. (Nottingham), Ph.D. (Newcastle-on-Tyne), C.Eng., P.Eng.	Phys.Sci.
H.G. Naidu	B.Sc. A.I.S.M. (Indian School of Mines), P.Eng.	Engineer

Geotechnical Engineering

B.Das	B.Sc., A.I.S.M. (Indian School of Mines), Ph.D. (Ostrava)	Res.Sci.

A. Stokes	B.Sc., Ph.D. (Nottingham)	Res.Sci.

Coal Reserve Assessment (Ottawa)

A.S. Romaniuk	B.Sc. (Queen's), P.Eng.	Phys.Sci.

FUEL PROCESSING LABORATORIES (DEVON)

H.A. Hamza	B.Sc. (Cairo), Ph.D. (Newcastle-on-Tyne)	Manager
N.E. Andersen	B.Sc. (Alberta)	Phys.Sci.
V. Marshman		Secretary

Fossil Fuel Science and Application

D. Axelson	B.Sc., Ph.D. (Toronto)	Res.Sci.
K.H. Michaelian	B.Sc. (California), Ph.D. (Simon Fraser)	Res.Sci.
R. Mikula	B.Sc. (Saskatchewan), Ph.D. (British Columbia)	Res.Sci.
Y. Theriault	B.Sc., M.Sc., Ph.D. (Alberta)	Res.Sci.
C. Angle	B.Sc. (Alberta)	Phys.Sci.
S. Twa	B.Sc. (British Columbia)	Phys.Sci.
R.G. Frenette	B.Sc. (Santo Tomas)	EG-ESS
G. Zuber		EG-ESS
X. Shu	Ph.D. (Imperial College)	PDF

Process Control and Computer Applications

J.L. Picard	B.Sc. (Alberta)	Phys.Sci.
W.I. Friesen	B.Sc. (Brock), Ph.D. (British Columbia)	Res.Sci.
N.A. Mansour	B.Sc. (Ain-Shams), B.Sc., Ph.D. (Alberta)	Res.Sci.
W.F. Mo	B.Sc. (Alberta)	Phys.Sci.
R. Ansari	Ph.D. (Western Ontario)	PDF

Engineering and Field Demonstration

K. Hashmi	B.Sc. (Alberta), P.Eng.	Engineer
Z. Potoczny	B.Sc., M.Sc. (Toronto)	Engineer
M. Hewlett		EG-ESS

Carbonization

A.B. Fung	B.Sc. (Waterloo), P.Eng.	Engineer
R. Zrobok	B.Sc. (Alberta)	Phys.Sci.
V. Munoz	B.Sc. (U of Chile)	EG-ESS
W. Silbernagel	B.Sc. (Calgary)	GL-MOC
K. McAuley		GL-MOC

Coal Preparation

M.W. Mikhail	B.Sc. (Assuit), M.Sc. (Alberta), P.Eng.	Engineer
A.I. Salama	B.Sc. (Alexandria), Ph.D. (Alberta)	Res.Sci.
I. Parsons	B.Sc. (Western Ontario)	Phys.Sci.
O. Humeniuk		EG-ESS

STAFF CHANGES

NEW EMPLOYEES

G. Zuber
J. Young
D. Permann
G. Glembiski
R. Cholak
Dr. Y. Theriault
S. Iwaskow
H. Brown
C. MacNeil
Dr. Z. Shu

RESIGNATIONS AND SEPARATIONS

J. Stevenson
Dr. J. Chu
K. Bukka
Dr. Y. Fisecki
D. Permann
G. Glembiski
R. Cholak

Deceased

Dr. W.M. Leung

APPENDIX D: PUBLICATIONS PRESENTATIONS AND PATENTS

PUBLICATIONS, PRESENTATIONS AND PATENTS

BOOKS

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Singhal, R.K., and Golosinski, T.S., "Automation and Remote Control of Continuous Mining Systems For Surface Mining of Oil Sands". Second International Conference on Innovative Mining Systems. The Pennsylvania State University, U.S.A., October 1986.

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Singhal, R.K., Fytas, K. and Collins, J.L. "Design, Construction and Maintenance of Surface Mine Haul Roads". International Symposium on Geotechnical Stability, Calgary, Canada, November 1986.

Srajer, V., "The Development and Validation of a Truck and Shovel Computer Model". Proceedings of 19th APCOM Conference, Penn. State University, University Park, Penn. U.S.A., 1986.

Srajer, V., "A Review of On-Board Truck Management Systems". Proceedings of the Third Conference on the Use of Computers in the Coal Industry, Morgantown, W. Virginia, U.S.A., July 1986.

Srajer, V., Sedlacek, J., "Application of Bucket Wheel Technology to Canadian Coal Mines". Proceedings of the Continuous Mining Symposium, Edmonton, Alberta, September 1986.

Szymanski, J., Mansour, N., "Time Dependent Rheology of a Western Canadian Coal Water Fuel". Proceeding of the Eighth International Symposium on Coal Slurry Fuels Preparation and Utilization, May 1986, Orlando.

Szymanski, J., Mansour, N., "A Novel Coal Water Fuel Instability Sensor". Proceedings of the Eighth International Symposium on Coal Slurry Fuels Preparation and Utilization, 1986, Orlando.

Szymanski, J., "Rheological Properties of a Western Canadian Coal Water Fuel". Proceedings of the Sixth International Workshop on Coal-Liquid and Alternate Fuels Technology, Halifax, Nova Scotia., October 1986.

Szymanski, J., Gladysiewicz, L., "Modelling of Long Conveyor Transients". International Symposium on Continuous Surface Mining", Edmonton, Canada, October 1986.

Szymanski, J. and Mansour, N.A., Shear and Concentration Dependent Rheology of a Western Canadian Coal/Water Fuel"; Proceedings of 11th International Conference on Slurry Technology, Hilton, Head; March 1986.

UNPUBLISHED PRESENTATIONS

Angle, C.W. "Role of Electrokinetics in Crude Emulsions Study"; Presentation to a joint CRL/Oil Industry Meeting; Alberta, April 1986.

Axelson, D.E., "NMR Applications to Heavy Oil Recovery Processes"; Presented at Syncrude, Alberta; 1986.

Axelson, D.E., "Applications of NMR to Industry"; Presented at the CIC, University of Alberta; June 1986.

Bonnell, G., Corbett, G., Hwang, J., Kennedy, D. and Young, D. "Equipment and Techniques for the Correct Measurement of Airborne Dust"; Presented to Lingan Colliery Safety Committee; November 1986.

Das, B., "Methane Desorption Characteristics in Coal Handling"; Presented to the Annual Meeting of the Calgary Branch of CIM; Calgary; December 1986.

Das, B., "Geotechnical Considerations in Surface Mining"; Presented to the Mining Engineering Students, University of Alberta: Edmonton; October 1986.

Das, B., "Natural and Artificial Support of Open Pit Slopes"; Presented to the Mining Engineering Students, University of Alberta, Edmonton; October 1986.

Friesen, W.I., "Emulsion Stability"; Presented to a joint CRL/Oil Industry Meeting, Devon, Alberta; April, 1986.

Hashmi, K.A., "Results of Field Testing of Obed Mountain Coal Washery" Presented to the Obed Washery Staff, Hinton, Alberta; September 1986.

Hashmi, K.A., "CANMET Mobile Plants Field Testing Units"; Presented to the Staff of Cassiar Asbestos Corporation, Cassiar, British Columbia; February 1987.

Hashmi, K.A., "Bench Scale and Mobile Pilot Scale Dewatering Facilities"; Presented to the Staff, Total Erickson Gold Mine Corporation; February 1987.

Haslett, G.A., Kennedy, D., Klinowski, G. and Stokes, A. "The Construction, Interpretation and Use of Flammability Triangles as Aids to the Evaluation of Mine Fires; Presented to Senior Production and Engineering Staff Members of the Cape Breton Development Corporation; December 1986.

Hassani, F.P., Afrouz, A. and Cain, P. "A Comparative Study of Monolithic Packs as Artificial Pillars"; Presented to CIM Symposium on Pillars in Mining; Saskatoon; September 1986.

Mansour, N.A., "Sensor Developments"; Presented at Morgantown Energy Laboratory, West Virginia, January 1986.

Mansour, N.A., "Microwaves"; Lecture presented to Electrical Engineering Department, University of West Virginia; January 1986.

Mikhail, M.W., "CRL Coal Preparation Research Facilities at Devon"; Presented at the CIMM Meeting in Rocky Mountain Branch, Alberta; May 1986.

Potoczny, Z.M., "Heavy Oil Mini-Plant"; Presented at the Oil Industry-CANMET Meeting, Coal Research Laboratory, Devon, Alberta; April 1986.

Romaniuk, A., "Coal Reserve Assessment in Energy, Mines and Resources Canada". Presented to the Reserves and Resources Reporting Seminar; Calgary, Alberta, November 1986.

Singhal, R.K., "Innovative Developments in Loading and Hauling Equipment for Surface Mines". Presented at CIM Rocky Mountain Branch; Edson, Alberta, March 1987.

Singhal, R.K. and Golosinski, T.S. "Equipment Selection in Surface Mining"; Presented as a mini-course in association with the 1986 National Symposium on Surface Mining, Hydrology, Sedimentology and Reclamation; Lexington, Kentucky, December 1986.

DIVISIONAL REPORTS

UNCLASSIFIED

ERP/CRL 86-22(OP,J)	Evaluation for the Acquisition and Use of Computers in Resource Evaluation and Mine Planning of Surface Mines in Oil Sands and Coal	R.K. Singhal
ERP/CRL 86-24(TR)	Nova Scotia Coal Resources Evaluation Project: Progress and Status of Coal Chemistry File January 1, 1985 to December 31, 1985	G.W. Bonnell
ERP/CRL 86-26(TR)	An Evaluation of 9 East's Monolithic Packing as a Gob Sealant	A.W. Stokes
ERP/CRL 86-27(IR)	Measurement of Performance of Hollow Shaft Ventilators and Drum Released Water Sprays on D.E.R.D. Shearer at Prince Mine	W.G. Klinowski G.A. Haslett
ERP/CRL 86-29(J,OP)	Selective Mining, Homogenization and Blending of Canada's Higher Sulphur Thermal Coals	R.K. Singhal D.G. Osborne
ERP/CRL 86-30(INT)	Cape Breton Coal Research Laboratory Annual Report: FY 85-86	G.A. Haslett
ERP/CRL 86-31(OP,J)	Rock Characterization through Microhardness Technique	B. Das
ERP/CRL 86-32(INT)	Calgary Coal Research Laboratory 1985-1986	Compiled by: H.G. Naidu
ERP/CRL 86-33(OP,J)	A Review of On-Board Truck Management Systems	V. Srajer

ERP/CRL 86-36(OP,J)	Rock Bolting and the Influence of Confining Stress Induced in the Rock Mass	B. Das B. Stimpson
ERP/CRL 86-39(OP,J)	Computer Analysis of the Effects of Mine Subsidence on Pipelines	V.J. Hucka H.J. Tu B. Das
ERP/CRL 86-40(TR)	Coal Reserves in Canada: 1985	H.G. Naidu
ERP/CRL 86-42(OP)	A Review and Evaluation of Empirical and Analytical Subsidence Prediction Techniques	T.R.C. Aston H.Y. Tammemagi A.W. Poon
ERP/CRL 86-43(OP)	Surface Mining Laboratory	D.B. Stewart
ERP/CRL 86-44(TR)	"DUROV Plot" Users Guide: Computer Calculation and Plotting of Durov Diagrams for Water Chemistry Analysis Using the IBM-AT	D. Zinck T.R.C. Aston
ERP/CRL 86-45(TR)	In Situ Gas Permeability Testing in the No. 2 and No. 3 Tunnels, Donkin-Morien Project, Nova Scotia	W.D. Gallant D.M. Hamilton T.R.C. Aston
ERP/CRL 86-46(OP,J)	Less Conventional Methods for Mining Underground Coal	I.R. Muirhead R.J. Kolada
ERP/CRL 86-50(OP,J)	A P Technique for the Prediction and Monitoring of Coal Oxidation	R.J. Mikula M.W. Mikhail
ERP/CRL 86-51(OP)	Surface Mining Equipment Selection: Developments in Loading and Hauling	R.K. Singhal
ERP/CRL 86-52(TR)	Pull Strength Testing of Resin Rebar Rock Bolts in Harbour Seam Driveage of Donkin Mine	W.D. Gallant
ERP/CRL 86-53(J)	A Review of Mining Subsidence Instrumentation and its Potential Application for Seabed Monitoring	D.J. Forrester T.R.C. Aston
ERP/CRL 86-55(TR)	The Effect of Monolithic Pumped Packing on Ventilation and Strata Control at Lingan Colliery, Nova Scotia	A.W. Stokes P. Cain

ERP/CRL 86-56(TR)	Coal Research Laboratories Annual Progress Report 1985-1986	Compiled by: G.A. Haslett H.G. Naidu K.H. Michaelian
ERP/CRL 86-58(OP)	An Investigation into the Effect on Varying Water Pressure and Flow Rates upon the Release of Airborne Respirable Dust by a Dosco MKIIB Roadheader Equipped with a Water Jet Assisted Cutting Head	G.A. Haslett G.R. Corbett D.A. Young
ERP/CRL 86-59(TR)	Geotechnical Engineering Discussion Document	B. Das M.Y. Fisekci N. Stuart
ERP/CRL 86-61(TR)	Field Trials of a Rapid Sequential Tracer Gas Analyzer	A.W. Stokes S.G. Hardcastle
ERP/CRL 86-63(OP)	Summary Report of Cooperative USBM/CANMET Research of Methane Flow Patterns on a Longwall Coal Mining Face	D.B. Stewart B.W. Konda
ERP/CRL 86-65(TR)	Advanced Technology Discussion Document	R.K. Singhal H.G. Naidu
ERP/CRL 86-66(TR)	Equipment Selection and Utilization in Surface Mining	R.K. Singhal
ERP/CRL 86-67(TR)	Environmental Control Discussion Document	R.N. Chakravorty R.J. Kolada
ERP/CRL 86-68(TR)	Operations Research Discussion Document	V. Srajer R.J. Kolada N.J. Stuart J.K. Szymanski
ERP/CRL 86-69(TR)	Further Characterization and Demulsification Studies on Oil-in-Water Emulsions	S.P. Twa
ERP/CRL 86-70(TR)	A Rapid Sequential Tracer Gas Analyzer Suitable for Use in the Underground Environment	D.J. Kennedy
ERP/CRL 86-71(TR)	Mineralogical Composition of Respirable Coal Mine Dust	C.Y. Hwang
ERP/CRL 86-72(TR)	An Improved Coal Preparation Procedure for Coking Tests	V.A. Munoz K.B. McAuley W.S. Silbernagel

ERP/CRL 86-73(OP,J)	Application of Bucket Wheel Technology to Canadian Coal Mines	V. Srajer J. Sedlacek
ERP/CRL 86-74(OP,J)	Basic Consideration in Selection of Bucket Wheel Excavators	R.K. Singhal T.S. Golosinski
ERP/CRL 86-75(OP,J)	Optimizing Loading and Hauling Productivity in Surface Mining	R.K. Singhal K. Fytas
ERP/CRL 86-76(OP)	Coal Reserve Assessment in CANMET: Some Issues	A.S. Romaniuk
ERP/CRL 86-79(TR)	'SUB#4' Users Guide: IBM-PC/AT Computer Calculation of Longwall Subsidence Profiles Using the NCB Subsidence Engineers Handbook	D.D. Zinck T.R.C. Aston
ERP/CRL 86-80(TR)	Prediction of Longitudinal and Subsidence Profiles with Width/Depth Ratios in Excess of 3.0 Using National Coal Board Methods	T.R.C. Aston
ERP/CRL 86-82(OP,J)	The Effect of Different Crushers on Fines Generation from Western Canadian Friable Coals	M.W. Mikhail R.J. Mikula O.E. Humeniuk
ERP/CRL 86-83(TR)	'Point Load Index' Users Guide: Computer Calculation of Point Load Indices and Rock Strengths Using an IBM-PC/AT	M. Issard T.R.C. Aston
ERP/CRL 86-93(OP)	Microseismic Data Processing Associated with Monitoring of Mine Slope Instabilities	N.J. Stuart T. Vladut
ERP/CRL 86-94(TR)	Determination of the Methane Released on 9 East Longwall Face Using SF_6 Derived Airflows	L.A. Chiasson A.W. Stokes
ERP/CRL 86-97(TR)	'Schmidt Hammer Rebound' Users Guide: IBM-PC/AT Computer Calculation of Uniaxial Compressive Strength Using the Schmidt Hammer	M. Issard T.R.C. Aston
ERP/CRL 86-98(OP,J)	Time Dependent Rheology of a Western Canadian Coal Water Fuel	J.K. Szymanski N.A. Mansour
ERP/CRL 86-100(OP,J)	Modelling of Long Conveyor Transients	J.K. Szymanski L. Gladysiewicz
ERP/CRL 86-101(IR)	Measurement of Performance of Hollow Shaft Ventilators on D.E.R.D. Shearers at Lingan Mine	W.G. Klinowski G.A. Haslett

ERP/CRL 86-102(TR)	The Vehicle Monitoring System at Widco Mine	V. Srajer
ERP/CRL 86-104(IR)	Triaxial Testing of Brittle Sandstone Using a Multiple Failure State Method	P. Cain C.M.K. Yuen G. LeBel A. Crawford D. Lau
ERP/CRL 86-105(OP,J)	Measurement of Respirable Dust Concentrations by Using Various Samplers in Underground Coal Mines	C.Y. Hwang
ERP/CRL 86-106(IR)	Analysis of Tracer Gas Data from a Study of Airflow Movements through a Leaching Stope in a Uranium Mine	A.W. Stokes W.G. Klinowski
ERP/CRL 86-108(OP)	Problems Associated with the Storage of Thermal Coal and their Potential Solutions	R.N Chakravorty H. Sahay
ERP/CRL 86-109(OP,J)	Rheological Properties of a Western Canadian Coal Water Fuel	J.K. Szymanski
ERP/CRL 86-110(TR)	The Potential for Cast Blasting in Canadian Surface Mines	H.G. Naidu R.K. Singhal G. Clausen J.A. Currie
ERP/CRL 86-111(TR)	A Numerical Method for the Calculation of Belt Conveyor Lengths as a Function of the Installed Power	J.K. Szymanski
ERP/CRL 86-112(INT)	Visit to Coal Mines in Craig, Colorado and USBM, Twin Cities Research Centre	H.G. Naidu
ERP/CRL 86-113(TR)	The Development of Computer Model of Continuous Digging Machine "Easi-Miner" at Obed Mountain Mine	V. Srajer G. Acott
ERP/CRL 86-114(TR)	Notes on Stripping Machinery Mass Estimates	V. Srajer M. Heximer W. Veldhuis
ERP/CRL 86-115(TR)	A Computer Program to Calculate the Rank of a Coal	G.R. Corbett G.W. Bonnell

ERP/CRL 86-116(OP)	The Influence of Design Parameters on Tunnel Closure in the Sydney Coalfield	A. Majdi F.P. Hassani P. Cain
ERP/CRL 86-117(IR)	Carbon/Carbonate Analysis of Rock/Gas Prone Sandstones from the Sydney Coalfield	P. Cain
ERP/CRL 86-118(IR)	Heat Generation of Bagged 'Astracem'	P. Cain
ERP/CRL 86-120(TR)	Preliminary Study and Site Selection for Blast Cast at Fording River Mine	H.G. Naidu
ERP/CRL 86-121(INT)	Visit Report on Visits Made in the U.K. September 5 - October 2, 1986	G.A. Haslett
ERP/CRL 86-122(TR)	Sensitivity Analysis of Production and Power Consumption to Various Constructional and Operating Factors Using a Computer Based Simulation Conveyor - Bin/Hopper Model	J.K. Szymanski
ERP/CRL 86-123(TR)	A Simplistic Classification of Western Canadian Coal Seams with Respect to their Potential for Development as Underground Mines	Richard Kolada
ERP/CRL 86-128(OP,J)	Fractal Dimensions of Coal Particles	W.I. Friesen R.J. Mikula
ERP/CRL 86-129(TR)	Digitizing Programs to Generate Input Data for a Haulage Simulation Model by Using Fitting Cubic Curves	C. Neumiller N. Stuart M. Heximer W. Veldhuis
ERP/CRL 86-130(INT)	ASTM Committee D-5 on Coal and Coke: October 1986 Meeting	G.W. Bonnell
ERP/CRL 86-132(OP,J)	Empirically Derived Formulae for Coal Pillar Strength	K. Barron B. Das
ERP/CRL 86-133(INT)	Attendance of the International Symposium on Respirable Dust in the Mineral Industries, October 14-16, 1986, University Park, Pennsylvania - A Visit Report	John C.Y. Hwang
ERP/CRL 86-134(OP)	Methane Control During Shipments of Coal	R.N. Chakravorty R. Lanteigne P.I. Forrester

ERP/CRL 86-135(OP,J)	Automation and Remote Control of Continuous Mining Systems for Surface Mining of Oil Sands	R.K. Singhal T.S. Golosinski
ERP/CRL 86-136(OP,J)	Design, Construction and Maintenance of Surface Mine Haulage Roads	J.L. Collins K. Fytas R.K. Singhal
ERP/CRL 86-137(OP,J)	Design Methods of Open Pit Coal Mining Footwalls	D.S. Cavers G.H. Baldwin T. Hannah R.K. Singhal
ERP/CRL 86-138(OP,J)	Numerical Modelling of Material Diggability	R.M. Krzanowsky R.K. Singhal
ERP/CRL 86-139(OP,J)	Continuous Mining Systems for Oil Sands Mining	R.K. Singhal H. Sahay S. Ghosh
ERP/CRL 86-140(TR)	An Update of the Use of the CANMET Telemetry System at the Syncrude Mine	N.J. Stuart
ERP/CRL 86-141(OP,J)	Chemical Characterization of an O/W Emulsion Interface Via Electron Microscope Observation of a Frozen Hydrated Sample	R.J. Mikula
ERP/CRL 86-142(OP,J)	Application of X-ray Microanalysis to Tar Sands Emulsions	R.J. Mikula
ERP/CRL 86-144(TR)	An Analysis of Easi-Miner Time Study Data at Obed Mountain Mine	J.K. Szymanski M. Heximer W. Veldhuis G.H. Larocque
ERP/CRL 86-145(TR)	Rheinland's Mine Hambach in West Germany	V. Srajer
ERP/CRL 86-146(TR)	Surface Coal Mining in Yugoslavia	V. Srajer
ERP/CRL 86-147(TR)	Lignite Mining in Ptolemais, Greece	V. Srajer
ERP/CRL 86-148(TR)	Airflow Distributions in 9 East Longwall	A.W. Stokes
ERP/CRL 86-149(INT)	Cross-Sensitivity of the BM2H Methane Monitor	D.J. Kennedy A.W. Stokes L.S. O'Leary

ERP/CRL 86-150(INT)	Visit to Mining Research Laboratories in the United Kingdom, France and West Germany	R.N. Chakravorty
ERP/CRL 86-151(TR)	Characterization of Western Canadian Coals with Respect to their Susceptability to Spontaneous Combustion	R.N. Chakravorty K. Kar
ERP/CRL 86-154(OP,J)	Continuous Mining Systems for Surface Mining of Coal	R.K. Singhal T.S. Golosinski
ERP/CRL 86-155(OP,J)	Surface Mining of Canadian Coal: Equipment Selection and Mining Methods	R.K. Singhal T.S. Golosinski
ERP/CRL 86-156(OP)	Velocity of Wave Propagation in a Dense Coal Water Suspension	J.K. Szymanski
ERP/CRL 87-1(OP,J)	Comparison of Fortran and GPSS Languages in the Simulation of a Shovel-Truck Open Pit Operation	K. Fytas E.B. Wilson
ERP/CRL 87-2(OP)	Photoacoustic FT-ID Spectroscopy Instrumentation and Computing	K.H. Michaelian
ERP/CRL 87-6(INT)	The Management and Use of Water in Underground Coal Mines	G.A. Haslett
ERP/CRL 87-7(TR)	Computer Aided Rapid Determination of the Explosibility of Mine Fire Gases	W.G. Klinowski
ERP/CRL 87-8(TR)	Remote Measurement of Methane in Coal Mines: A Review	B.W. Konda R.C. Mitchner A.B. Hollinger

CONFIDENTIAL REPORTS

ERP/CRL 86-47(CF)	Coal Dustiness: Preliminary Evaluation of Smoky River Coal	R.J. Mikula W.M. Leung
ERP/CRL 86-48(CF)	Coal Dustiness: Field Testing Dust Suppressants; Smoky River Coal	R.J. Mikula W.M. Leung
ERP/CRL 86-49(CF)	Coal Dustiness: Final Evaluation of Smoky River Coal	R.J. Mikula W.M. Leung G. Zuber

ERP/CRL 86-54(CF)	Characterization and Demulsification Studies on Oil-in-Water Emulsions Part 2	S.P. Twa D.E. Axelson H.A. Hamza
ERP/CRL 86-60(CF)	Recovery of Resins from Coal Identified as Upper Seam -- Bowron River Property.	J.L. Picard
ERP/CRL 86-62(CF)	An Evaluation of Anemometry Techniques	A.W. Stokes D.J. Genter
ERP/CRL 86-64(CF)	Low Rank Coal Upgrading: Part 1	D.E. Axelson R.J. Mikula V. Munoz
ERP/CRL 86-78(CF)	CBCRL Response to Lingan Colliery Mine Extension Planning.	T.R.C. Aston P. Cain G.A. Haslett A.W. Stokes
ERP/CRL 86-81(CF)	Carbon-13 Solid State Nuclear Magnetic Resonance Spectroscopy of Pitch	David E. Axelson
ERP/CRL 86-84(CF)	An Evaluation of Subsidence Criteria for the East and West Side Panels, Phalen Mine, Sydney Coalfield, N.S.	T.R.C. Aston
ERP/CRL 86-85(CF)	Thermogravimetric Studies of the Sulfur Absorption Capabilities of Alberta Limestones	W.M. Leung
ERP/CRL 86-86(CF)	Description of Loading and Hauling Operations at Quintette Mine	V. Srajer
ERP/CRL 86-87(CF)	Description of Loading and Hauling Operations at Luscar Mine	V. Srajer
ERP/CRL 86-88(CF)	Description of Loading and Hauling Operations at Coal Valley Mine	V. Srajer
ERP/CRL 86-89(CF)	Description of Loading and Hauling Operations at Coal Mountain Mine	V. Srajer
ERP/CRL 86-90(CF)	Description of Loading and Hauling Operations at Gregg River Mine	V. Srajer
ERP/CRL 86-91(CF)	Description of Loading and Hauling Operations at Harmer Mine	V. Srajer
ERP/CRL 86-92(CF)	Description of Loading and Hauling Operations at Line Creek Mine	V. Srajer

ERP/CRL 86-99(CF)	Evaluation of Polymers and Filtration Performance of Brazilian Bleaching Clay	R. Frenette
ERP/CRL 86-103(CF)	Upgrading Low Rank Coal: The Weco Process	R.J. Mikula D.E. Axelson V.A. Munoz
ERP/CRL 86-107(CF)	Application of Petrography and Scanning Electron Microscopy in Studying Coal Handling Problems	R.J. Mikula V.A. Munoz
ERP/CRL 86-119(CF)	Evaluation of Demulsifier Variability by Carbon-13 Nuclear Magnetic Resonance Spectroscopy. Correlations with Plant Performance	D.E. Axelson Y. Theriault
ERP/CRL 86-124(CF)	Coker Feed Variability	D.E. Axelson R.J. Mikula
ERP/CRL 86-125(CF)	Carbon-13 Solid State NMR Characterization of Natural Surfactants derived from Heavy Oil	D.E. Axelson
ERP/CRL 86-126(CF)	Characterization of Existent Dry Sludge	D.E. Axelson R.J. Mikula
ERP/CRL 86-127(CF)	Petrographic Characterization of Thickener Feed Samples	V.A. Munoz
ERP/CRL 86-131(CF)	Respirable Dust Measurements Made at Prince Colliery during the Period December 1985 - June 1986	C.Y. Hwang G.W. Bonnell G.R. Corbett C.H. MacNeil D.A. Young L.S. O'Leary D.J. O'Brien
ERP/CRL 86-152(CF)	A Scanning Electron Microscope Study of Selected Partial Combustion Samples	R.J. Mikula
ERP/CRL 86-153(CF)	Optical Microscope Study of Emulsion Aging	V.A. Munoz
ERP/CRL 87-3(CF)	Particle Size Effects on the Performance of Gamma-Ray Density Meters	N.A. Mansour J. Szymanski
ERP/CRL 87-4(CF)	Optimization of a Coal Tailings Dewatering Circuits at Cardinal River Coals I. Work Plan	K.A. Hashmi H.A. Hamza

ERP/CRL 87-5(CF)	Potential Instrumentation Schemes for Monitoring Interaction Effects and Subsidence Profile Development Over the Phalen Mine 1 West Panel	T.R.C. Aston W.D. Gallant

APPENDIX E: REPRESENTATION ON TECHNICAL COMMITTEES

INTERNATIONAL

Canada/Federal Republic of Germany Science and Technology Agreement

Coal Slurry Pipelines

Co-ordinator ..... T.D. Brown

Project leader ..... M.W. Mikhail

American Society for Testing Materials

CRL representative ..... G.W. Bonnell

International Standards Organization

ISO TC 27/SCI. Convenor ..... H.A. Hamza

INTERNATIONAL PUBLICATIONS

Fuel Processing Technology

Editorial Advisory Board ..... H.A. Hamza

International Journal of Mine Water

Canadian editor ..... T.R.C. Aston

World Mining Equipment

Editorial Advisory Board ..... R.K. Singhal

International Journal Surface Mining

Editor ..... R.K. Singhal

Coal Preparation - International Journal

Editorial Board ..... M.W. Mikhail

Computers and Mining

Contributing Editor ..... R.K. Singhal

INTERNATIONAL SYMPOSIA

Eighth International Strata Control Conference Organizing Committee

Canadian Representative ..... D.B. Stewart

Twenty-Second International Conference of Safety in Mines Research Institutes

Canadian Representative ..... D.B. Stewart

International Symposium on Geotechnical Stability in Surface Mining

Symposium Organizing Committee (chairman) ..... R.K. Singhal

International Symposium on Continuous Surface Mining

Symposium Organizing Committee (member) ..... R.K. Singhal

Tenth International Coal Preparation Congress (1986)

Steering Committee (member) ..... T.D. Brown
Technical Program Committee (chairman) ..... M.W. Mikhail
Foreign Languages Committee (chairman) ..... A.S. Romaniuk

Eleventh International Coal Preparation Congress (1990)

Canadian representative ..... M.W. Mikhail

National Symposium on Surface Mining, Hydrology, Sedimentology, U.S.A.

Technical Program Committee (member) ..... R.K. Singhal

Institution of Mining and Metallurgy (UK)

Mining Industry Editorial Advisory Board ..... R.K. Singhal

CANADA

Canadian Institute of Mining and Metallurgy, Coal Division

Steering Committee (member) ..... T.D. Brown
Executive Committee (2nd vice-chairman) ..... A.S. Romaniuk
Research Grant for Mining Technology Committee (member) D.B. Stewart
Technical Program Committee (chairman) ..... G. Zahary
Technical Program Committee (member) ..... D.B. Stewart

Newsletter Editor ..... R.K. Singhal

CAPCC (representative) ..... B. Das

Coal Preparation Section (vice chairman) ..... M.W. Mikhail

Canadian Institute of Mining and Metallurgy, Rock Mechanics and Strata Control

Rock Bursts and Microseismic Systems Subcommittee (member) . P.R.M. Cain
Sedimentary Structures and Subsidence Subcommittee (member) T.R.C. Aston
Instrumentation Subcommittee (member) ..... P.R.M. Cain
Hydro-Carbon Subcommittee (member) ..... R.K. Singhal

Canadian Institute of Mining and Metallurgy Computer Application and Process Control Committee

Executive Committee (member) ..... B. Das
Publications (chairman) ..... B. Das

Canadian Institute of Mining and Metallurgy

Publication Committee (member) ..... B. Das

Canadian Mining Journal

Editorial Advisory Board ..... R.K. Singhal

Frictional Ignition Working Group (Cape Breton)

(member, secretary) ..... G.A. Haslett

Microscopical Society of Canada (Alberta Branch)

Steering Committee (member) ..... R.J. Mikula

Coal Preparation Research Association of Canada

Secretary ..... M.W. Mikhail

Alberta Office of Coal Research and Technology

Federal Representative ..... T.D. Brown

Technical Panel (EMR representative) ..... D.E. Axelson

Alberta Wheat Pool Steering Committee

EMR representative ..... W.I. Friesen

Advisory Committee for Canada - Saskatchewan Project on Pipelining of Heavy Crude Oils

(member) ..... M.W. Mikhail

Committee on Atlantic Coal (member) ..... T.D. Brown

Coal Beneficiation Working Group (member) ..... M.W. Mikhail

MISCELLANEOUS

Youth Science Foundation

Science Lecture Program ..... R.K. Singhal

APPENDIX F: RESEARCH CONTRACTS, JOINTLY FUNDED WORK AND COST RECOVERY ACTIVITIES

RESEARCH CONTRACTS

CAPE BRETON COAL RESEARCH LABORATORY

Title	Investigator	Scientific Authority	Status March 31/87
Overcoring and Minifracing In Situ Stress Determinations at the Lingan and Prince Mines, Sydney Coalfield, N.S.	Golder Associates Toronto, Ont.	T.R.C. Aston	Completed
An Examination of Archival Geophysical Data from the Sydney Coalfield, Nova Scotia to Identify Seafloor Longwall Subsidence Profiles	McGregor Geoscience Ltd. Halifax, N.S.	T.R.C. Aston	Completed
Evaluation of Grout Filled Lightweight Tubular Steel as an Alternative to Conventional Support in Large Excavations in Coal Mines or Other Places Subject to High Stress	Technical University of Nova Scotia Halifax, N.S.	P. Cain	Completed
Development and Laboratory Validation of a Theoretical Model of Rock/Gas Outbursts for the Sydney Coalfield	Golder Associates Toronto, Ont.	P. Cain	Continuing
Technical Review of Water Jet/ Jet Assisted Cutting	International Energy Agency London, U.K.	G.A. Haslett	Completed
Design and Construction of an Apparatus to Conduct Methane Gas Studies on Canadian Coals	Zenon Environmental Inc. Burlington, Ont.	B.W. Konda	Continuing

Operational Experience with the Conspec Remote Environmental Monitoring System in an Operating Underground Canadian Coal Mine	Cape Breton Development Corporation Sydney, N.S.	B.W. Konda	Continuing

SURFACE MINING LABORATORY

	Investigator	Scientific Authority	Status March 31/87
Biological Control of Methane in Coal Mines Coal Silos and Ship Holds Phase IV	Gemini Biochemical Research Ltd., Calgary	R.N. Chakravorty	Completed
Design and Construction of a Test Apparatus for Evaluating Spontaneous Combustion Susceptibility of Canadian Coals - Phase I	Associated Mining Consultants Ltd., Calgary	R.N. Chakravorty	Completed
Development of Design Criteria for Steeply Dipping Footwall Stability in Mountain Regions	Hardy Associates (1978) Ltd.	R.K. Singhal	Completed
Demonstration and Evaluation of Blast Casting in a Producing Canadian Surface Coal Mine	Fording Coal Ltd.	H.G. Naidu	Continuing
Demonstration and Evaluation of an Integrated Truck Management System in a Producing Canadian Surface Coal Mine	Gregg River Resources Ltd.	V. Srajer	Continuing
Assessment, Evaluation and Validation of a Computer Based Simulation Model of a BWE/ Conveyor/Bin System	Monenco Consultants Ltd., Calgary	V. Srajer	Completed

Upgrading and Maintenance of CANMET's Radio Telemetry System	Ecological and Resources Consultants, Fredericton New Brunswick	N.J. Stuart	Completed
Application of the Stress-Property-Deformation-Relation (SPDR) Integrated Method in Determining Surface Mine Stability	Serata Geomechanics Inc., Richlands, California	B. Das	Continuing
Determining Geotechnical and Hydrogeological Properties of Overburden in Oil Sands Mining using Downhole Geophysics	TransAlta Utilities Corp. Calgary, Alberta	B. Das	Continuing
Regional Study of Coal Mine Waste Dumps in British Columbia, Stage II	Golder Associates (Western Canada) Ltd.	B. Das	Completed
Towable Vehicle to Measure Mine Haulage Road Rolling Resistance	David Engineering Ltd., Ottawa	R. Kolada	Completed
Assess Field Techniques Used to Determine Insitu Specific Gravity of Coal	Norwest Resource Consultants Ltd., Calgary, Alberta	A. Romaniuk	Continuing

FUEL PROCESSING LABORATORY

Analytical Methods for the Determination of Trace Polymers in Coal and Oil Process Waters	Guelph Chemical Labs. Guelph, Ontario	D.E. Axelson	Continuing
Analysis of Minerals in Coal	David Pearson & Associates Victoria, B.C.	A. Mo	Completed

Coal Sample Analysis of Washery Products	Loring Laboratory Calgary, Alberta	I.S. Parsons	Completed
Comparative Examination of Fly Ash and Magnetite Heavy media for Coal Beneficiation	Research and Productivity Council - N.B.	J. Szymanski	Completed
Determination of the Relationship Between Bound and Unbound Polyacrylamide	St. Francis Xavier University, N.S.	C.W. Angle	Continuing
Development of Electromagnetic Techniques and Methods for Evaluation of Particulate Contents of a Solid or a Liquid Dispersed in another Liquid such as Water	Northern Unconventional Power Research Edmonton, Alberta	N.A. Mansour	Completed
Further Development, Testing and Application to Coals and Clays Using a Conical Fluidized Bed	J.C. Donini St. Francis Xavier University, N.S.	W.I. Friesen	Continuing
A Study of Electrostatic Separation of Water-in-Oil Emulsions	S. Levine Vancouver, B.C.	W.I. Friesen	Completed
Innovative Flotation of Eastern Canadian Coal	Paul Shibley & Assoc. Ltd. Toronto, Ontario	I.S. Parsons	Completed
Water Analysis of Coal Washery Products	Norwest Laboratories Edmonton, Alberta	I.S. Parsons	Completed
Design & Construction of a Heavy Oil Mini-Plant	D.B. Stearns Engineering Calgary, Alberta	Z. Potoczny	Continuing

COST RECOVERY AND COLLABORATIVE RESEARCH

A significant number of cost recovery and collaborative projects were undertaken on behalf of western Canadian industries during FY 86/87 and reported, on a confidential basis, to the research clients. The summary tables below illustrate the distribution of these projects between the technology areas in which the division operates.

Cost Recovery Activities

Coal Technologies		$000's
Carbonization	6 companies	$ 80
Preparation	3 companies	$ 30
Upgrading	2 companies	$ 40
Spontaneous Combustion	2 companies	$ 20
Oil Emulsion Technologies	2 companies	$ 80
Special Studies	2 companies	$ 10

Collaborative Activities

Formal financial agreements support the projects identified below: cooperative projects without formal cost sharing agreements are not included but they are also significant.

($000's)	Company Contribution ($000's)	CANMET Contribution
Slope Stability	200	150
Blast Casting	160	100
Truck Management	155	100
Downhole Geophysics	75	75
Biological Control of Methane*	25	30
Waste Dump Stability**	50	20

Additional contributions from * Transport Canada ($35K)
** Canada/British Columbia Mineral Development Agreement ($30K)

CAPE BRETON COAL RESEARCH LABORATORY

Discussion with Cape Breton Development Corporation (CBDC) staff has remained a normal day-to-day event as have visits to CBDC mines by CBCRL staff.

The comparative isolation of CBCRL relative to other CANMET and CRL facilities predicates a requirement that scientists must travel to present papers, to exchange information and to discuss ongoing research with other scientists. Such travel serves to keep CBCRL staff abreast of relevant developments elsewhere and avoids duplication of effort.

One example from among a number during the past year, will serve to illustrate the principle. An exchange visit allowed a CBCRL scientist to work for three months at CERCHAR's Laboratoire du Mecanique des Terrains at Nancy, France with intent to improve our knowledge on European roadway support methods with wood replacement materials. Wood replacement is a vital component in the reduction of the risk of fire in underground coal mines.

The "return" element of the exchange package was completed in December 1986 when a visiting French scientist completed a three month visit to the Surface Mining Laboratory in Devon.

The relevance of CBCRL programs to industry needs is assured by frequent formal and informal contact during all phases of each project. Laboratory staff lead a number of informal technology specific working parties that serve as a fertile spawning ground for research ideas. They are also lively participants in day-to-day CBDC technical problem solving discussions. These discussions coupled with the frequent visits to CBDC mines ensure that laboratory staff remain up to date and aware of developments within the mines of their main client.

SURFACE MINING LABORATORY

The redirection of the laboratory coupled with attempts to promote more durable industry contacts and cooperative research projects have all resulted in enhanced discussion with industry, associated regulatory agencies and the Coal Association of Canada. Industry understanding of the mandate and objectives of the laboratory is now broadly based. Suggestions and ideas for potential research projects of both a site-specific and generic nature are being increasingly received from industry.

Direct technology transfer to industry has been improved by laboratory organization of technology specific symposiums, workshops and briefings of completed work. Such efforts are time consuming but serve to disseminate research findings more effectively to our clients and provide direct feedback to laboratory staff.

The Surface Mining Laboratory maintains continuous contact with foreign and off-shore research organizations, mine operators and equipment manufacturers. Staff participate actively in national and international technical committees and maintain contact, including guest lecturing, at Canadian Universities. These actions ensure that we remain current and allow us to assess the potential future impacts of emerging and new developments in the Canadian context.

FUEL PROCESSING LABORATORY

All staff have maintained continuous face-to-face interaction with representatives of the coal, oil and chemical industries as well as with research organizations and educational centres around the world. This has been achieved by receiprocal visits, field trips, in-house meetings, industry-wide surveys and seminars.

Researchers are now involved in collaborative work with many elements of western Canadian industry as well as with the following organizations: Alberta Environment, Argonne National Laboratory (Division

of Chemistry, Argonne, Ill.), Agriculture Canada (Pacific Forestry Centre, Victoria, B.C.), University of Alberta, Florida State University, University of Heidelberg, University of New Hampshire, Queen's University, University of Saskatchewan, University of Victoria, Bruker Canada and Bruker Analytische, Messtechnik GmbH.